THE GEOGRAPHICAL JOURNAL

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THE ROYAL GEOGRAPHICAL SOCIETY, LONDON, S.W.7

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NEW GEOGRAPHICAL LITERATURE AND MAPS

While the number of orders received for this work as a result of the insertion of an order form in the last issue of the Journal is encouraging, it is necessary to increase the circulation considerably if the project is to be justified. Fellows and others are reminded that apart from their use as a bibliography of geographical literature the lists will be useful as a subject catalogue of recent additions to the Library and Map Room, and will thus be of value to those who are not often able to consult the full card index.

ROYAL GEOGRAPHICAL SOCIETY

NOTICES

PROGRAMME OF MEETINGS

Monday October 22 *at* 8.15 *p.m.*
THE KALAHARI TODAY. *By Professor Frank Debenham*

Monday October 29 *at* 5.30 *p.m.*
FROM NEW ORLEANS TO URUGUAY. *Kodachrome films with commentary by G. C. Schluter*

Monday November 5 *at* 5 *p.m.*
GLACIER INVESTIGATION BY TUNNELLING. *By W. V. Lewis*

Thursday November 8 *at* 5.30 *p.m.*
FILM MEETING FOR TEACHERS OF GEOGRAPHY
(*The growth of London, Great Britain, and Life in the Pyrenees*)

Friday November 16 *at* 5 *p.m.*
NAVIGATIONAL WORK WITH THE POLAR SHIP *NORSEL*. *By Lieutenant L. R. R. Foster, R.N.*
A meeting of the Institute of Navigation.

Monday November 19 *at* 8.15 *p.m.*
FRENCH EXPLORATIONS IN ANTARCTICA. *By Andié Liotard*

Monday December 3 *at* 5.30 *p.m.*
KINGDOM OF JORDAN. *Kodachrome films with commentary by Sir Clarmont Skrine.*

Monday December 10 *at* 5 *p.m.*
EROSION SURFACES OF THE EXMOOR AREA. *By W. G. V. Balchin*

Monday December 17 *at* 8.15 *p.m.*
GEOGRAPHY OF POWER. *By the Rt. Hon. the Earl of Verulam, J. Houston Angus, and Stephen Chaplin*

Friday December 21 *at* 5 *p.m.*
METEOROLOGY AND NAVIGATION. *By Lieutenant-Commander P. G. Satow, D.S.C., R.N.*
A meeting of the Institute of Navigation.

Light refreshments for Fellows and their guests will be served in the New Map Room after the Evening Meetings. Fellows are reminded that, unless special application is made, only one guest may be brought to Evening Meetings.

PROPOSAL FORM FOR FELLOWSHIP

Fellows will find printed at page *v* a proposal form for their use should they wish to recommend a candidate for election to Fellowship.

THE SOCIETY'S HOUSE

The House of the Society is open from 9.30 a.m. to 5 p.m. on weekdays and from 9.30 a.m. to 1 p.m. on Saturdays. The Library is also open for the exchange of books from 7.30 to 8 p.m. before Evening Meetings.

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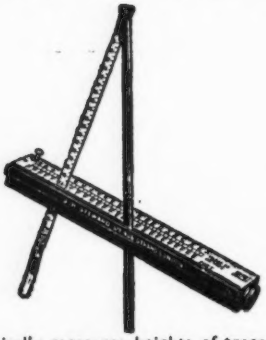

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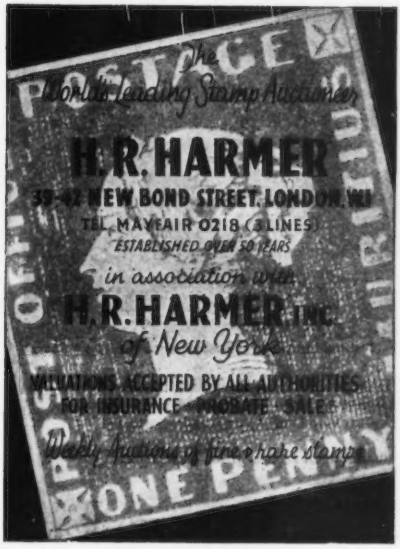

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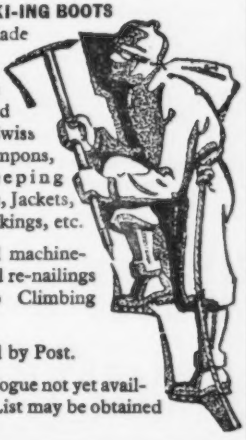

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The
GEOGRAPHICAL JOURNAL

Vol CXVII Part 3 *September 1951*

THE PRESIDENTIAL ADDRESS, 1951

SIR HARRY LINDSAY, K.C.I.E., C.B.E.

IT IS CUSTOMARY to distinguish between theoretical knowledge and practical knowledge, and I propose in this Address to approach the science of Geography from this dual aspect, of theory and of practice. I suppose that every science might be regarded from these two points of view; and that the sequence would be: Experiments to provide experience; experiences to provide data; data to build up knowledge; knowledge as the raw material on which theories are constructed; theories as the bases for new experiments; these experiments to provide experience; and so on *ad infinitum*. Indeed one can scarcely conceive of any science which is, so to speak, the last word on its own subject, a sealed book requiring only an index to complete it and with no scope for supplementary volumes because Volume I covered the whole ground. That is an untenable, almost an unthinkable, proposition.

Now I do not want you to imagine from this introduction that I am going to give you a learned disquisition on the theory and practice of Geography as pure science. That would be far beyond my capacity; nor indeed, if I were to attempt it, do I think that I should be able to hold your attention for very long. So I propose to work out my thesis in quite a different way, for I have only a limited time in which to try and interest you. What is my quickest and surest line of approach, calculated, almost guaranteed, to ensure your interested attention?

The answer is of course that the one subject which has brought you all together this afternoon, and therefore the one likely to interest the whole of my audience, is the work of the Royal Geographical Society. I propose therefore to take as my theme the post-war organization and achievements of the Society, covering as best I may the three past years 1948–9, 1949–50 and 1950–1. These three years have seen the Society emerge successfully from the Second World War. They have seen developments, of no little interest, in the work of the Society. They therefore afford quite good material on which to base a study of the Society, actively concerned both with the theory and with the practice of Geography.

And may I add one final word to my introduction? I propose to base this study on a survey of the work of the various committees through which the Society functions. They are, after all, the chosen instruments which the Society has itself set up. They help it to fulfil its legitimate aims and objects;

they are the media through which it expresses itself and carries out its inherited responsibilities; and those responsibilities, as I am sure you will all agree, play a not insignificant part in the national life of this country.

Let me then concentrate first on the work of your Research and Expeditions Committee, whose very title suggests that it exists in order to reconcile the theory with the practice of Geography. The main developments of this Committee, under the able chairmanship of Professor J. A. Steers of Cambridge, have been not only the expansion of the Society's support for expeditions, especially undergraduate expeditions, but also the much closer correlation than perhaps there ever has been in the past between the practice of exploration and the theories which are tested by research. This has been achieved very largely through the Committee's exacting examination of expedition programmes and by their insistence on, not a biological nor an ornithological nor any other specialist contribution, but on a geographical contribution. Their criterion has been " Where is the geography in all this?" as well as "Where is the geographer?" With the present large output of qualified geographers from the Universities, the Committee has done its utmost to ensure that any expedition supported by the Society should contain at least one geographer. It is, of course, possible to pursue this policy to excess. There are many expeditions with no specific geographical programme in the academic sense, yet whose combined results provide extremely valuable contributions to geography. Moreover, by no means all the most valuable contributions have been made only by trained geographers. But on the whole, as I think you will agree, it is a development in keeping with our main object, the advancement of geographical science, and in line with the scientific approach of today. In the last three years the Research and Expeditions Committee has recommended support for thirty-four expeditions working outside the British Isles. I need hardly add that the Society, in finding means to finance these expeditions, has been greatly helped as before by the *Geographical Magazine* Trust.

The formation of the Education Committee in 1947 was in many ways a new development. Under the Chairmanship of Dr. Laborde, for many years senior geography master at Harrow, this Committee quickly made its mark. You will all remember its pamphlet 'Geography and social studies in schools,' which produced a flood of comments and argument in the Press. Whilst provoking very lively discussions on a most vexed question, this pamphlet sets out to right a situation on the wrongs of which the Committee had no doubts. Another venture was the pamphlet 'Careers for geographers.' On this, I need only say that it has been in constant and increasing demand. Then there have been the film meetings for teachers; in providing a forum for the criticism of films for teaching the Committee has done a service not only to school teachers as a class, but also to the makers of educational films. Connected with all this educational work have been our annual exhibitions which have embraced a wide and interesting range of subjects such as Navigation, African exploration, Colonial mapping and Bird migration. These were all subjects in which geographers had something to learn and much to impart to the general public.

So much for research and so much for education. Now let me break new

ground by considering the identification of education with research, secured by your Publications Committee which has functioned for many years under the active Chairmanship of Mr. J. M. Wordie. Its chief duty is, of course, to serve as the Editorial Committee for the *Geographical Journal*, now alas only appearing quarterly as a result of high costs and the shortage of paper. With paper more than four times its pre-war price, with printing up by over 110 per cent. and binding three and a half times its cost in 1939, and with all these charges steadily rising, it does not seem as if we should ever revert to the old monthly issues. Nevertheless we have done our best to continue the essential work of publication in other directions. In 1948, the first of a new and special Research Series appeared, with Professor Hans Ahlmann's 'Glaciological research on the North Atlantic coasts.' Another memoir, the work of Mr. J. N. Jennings on the origin of the Broads, is in hand. Several new pamphlets have appeared; one is on the medieval Hereford World Map, which you may remember was restored and framed by the Society before its return to Hereford Cathedral, another on Air Survey and recently yet another on the work of the late Sir Halford Mackinder, republishing his two most famous papers from early numbers of the *Journal*. In prospect is a new and badly needed edition of 'Hints to Travellers' and a definitive publication by our Librarian and Map Curator, Mr. Crone, on the Hereford Map.

This reference to maps brings me to the Survey Committee, under the Chairmanship of Brigadier Hotine, Director of Colonial Surveys, and to the Library and Maps Committee, over which I am privileged to preside. The Survey Committee, responsible for advice on cartography and survey, works closely with our Instructor in Survey, Mr. Alfred Stephenson. On the cartographical side the most valuable recent contribution has without doubt been the map of south-eastern Arabia, from traverses made by our Gold Medallist Wilfred Thesiger in a series of most remarkable journeys in Arabia since the War. This map was published in the *Journal*, which will continue to contain examples of such cartographical work, so admirably drawn by Mr. Holland and our Drawing Office staff. But we hope also to resume the publication of maps in sheet form and two of these, a map of the Hadhramaut in the Aden Protectorate and a map of Mount Everest, are already in hand.

Perhaps the most important of the Society's services, not only to Fellows but to Government Departments and to the public, is rendered through our Library and by our unrivalled Map Collection; the latter, as you know, housed in a public Map Room in return for which we receive a treasury grant. The problems which face your Library and Maps Committee are largely administrative in character. They are none the less interesting and valuable, and indeed what is administration but the reconciliation of theory with practice? During the course of the past three years, the Library Periodical Store has been rearranged and indexed, and cards showing the position of sets have been placed on the cases, thus enabling users to find the sets for themselves. The old and less used works in the main Library have been transferred to the Gallery thus making room for new books; so far, Europe, Africa and Australia have been transferred. The author card index has been separated into two sections—books and periodicals; and the card index of periodicals

has been checked and brought up to date. Owing to war damage repairs all the Gallery cases had to be moved, but now they have been put back, and new steel cases installed giving several hundred feet of extra shelving; part of the Andrews Room has been rearranged and the Survey section completed—the rest is in progress.

With the help of a small *ad hoc* committee your Museum has been reorganized. The exhibits are now displayed in show-cases labelled according to continents and explorers. The same arrangement has been extended to the preparation of a series of new maps by Mr. Jordan, which will shortly adorn the walls of the Museum. These will show, by continental areas, the chief expeditions carried out with the cooperation of the Society since its foundation in 1830, together with the names of the explorers concerned.

There is one Committee I have not so far mentioned which has during the last three years supplemented the work of our normal Committees. That is the Joint Polar Committee of the Society and of the Scott Polar Research Institute. It has been under the Chairmanship of one who is a veritable encyclopaedia of experience and knowledge of the Polar Regions, Mr. J. M. Wordie, and its chief function has been to act as the British Committee for the Anglo-Scandinavian Antarctic expedition which returns to Europe next year. There is no need for me to elaborate on this. You will have followed the fortunes of the expedition in the periodical dispatches to *The Times* from the Norwegian leader, Captain John Giaever, or in our own *Journal*. It has turned out to be not only a new and remarkably successful experiment in international cooperation, but also a scientific enterprise of the first importance. Its success so far has been marred only by the tragic accident earlier this year in which three invaluable members, Corporal Quar of the R.A.F., John Jelbart, a young Australian physicist of great promise, and Bertil Ekstrom of Sweden, lost their lives.

All these Committees, engaged in their different ways in the promotion of science and exploration, hinge in the last resort on the more prosaic but no less valuable work of the Finance and House Committee. Until last year under the indefatigable Chairmanship of Mr. Brooks, and since then under the Chairmanship of our distinguished Honorary Treasurer, Lord Catto, this Committee has guided the Society's finances through a period since the War about as discouraging for societies like ours as it could possibly be. Despite shortages and rising costs we have continued to survive, if not to prosper, and for this we are considerably indebted to the wise counsels of our Finance Committee. We have added 1214 members to our Fellowship since the war, 564 of them during the last three years, and are now within 228 of our record figure of 6452 in 1930. Associate Members, too, who are a new feature since 1947, now number 156 and provide a constant source of recruitment for Fellowship. A non-contributory pension fund has been set up for the older members of the staff. A considerable scheme of redecoration and improvement has been carried out in the Society's House for the benefit of Fellows.

All this, with the costs of maintaining our great collections, of publication, and of supporting exploration for which there are more and more calls each year, has presented our Finance Committee with formidable

problems. The answer is, of course, more money; and here we are in a dilemma. We are strongly opposed to increasing our Fellowship at the expense of quality: on the other hand, only in the last resort will we increase the subscription which still is almost unique in remaining at the 1908 level. This we may well have to do in the end, but meanwhile we hope that donations and legacies, such as the most generous legacy of the late Mrs. Hyde Maberley, may see us through. Bequests on which only a small legacy duty is levied may well commend themselves to supporters of our aims and interests as a very useful form of assistance. As I have said, an increase in our subscription may be inevitable. Meanwhile through voluntary contributions and appeals, even by a public appeal for special purposes such as exploration, we hope to stave off the evil day.

With all this concentration on exploration and research and the means to stimulate and push forward these main objectives of our Society, we have not been unmindful of another important duty, our duty to our own Fellows. Since the War, despite our financial problems, we have gradually completed the repairs and redecoration of much, though not all, of our House. This year we have opened a new tea-room, more spacious and opening out into the garden where teas can also be served in limited numbers. This rearrangement has had another advantage in making available two small rooms on the second floor for students, for small discussion groups and for expeditions like the Norwegian–British–Swedish Antarctic Expedition whose British headquarters have been located here during the last two years. We hope, too, to purchase new carpets and, most pressing of all, we hope to improve the internal lighting of the house which is still, much of it, in a somewhat Victorian stage of development.

All this takes time and labour and money. But in these and other ways we will continue to improve and increase the amenities of the House for our Fellows.

There is one further matter to which I should like to refer, especially appropriate in this centenary year of British achievement, and that is the David Livingstone Memorial. The memorial as many of you know was erected in 1902 at Old Chitambo's village, near the southern shores of Lake Bangweulu in Northern Rhodesia, over the site of the tree under which the explorer's heart was buried on 1 May 1873. Until last year it had been maintained out of a fund set up for its erection by the Society, originally with the cooperation of a Committee under Sir Henry Morton Stanley. Now however the care of this memorial has been taken over by the Northern Rhodesian Government, and the Society has been considering how best to use the balance of the original Memorial Fund. After considerable discussion, your Council has decided to erect our own memorial to Livingstone. He was a Fellow of the Society and a Gold Medallist and, after his famous and tragic last journey, his body lay in state for two days in the Map Room of the Society's old House at Savile Row in 1874. There, as Mill puts it, "the public filed past in tribute to the greatness of this unexampled traveller." The empty niche on the north outer wall of our Hall is ready to receive a monument; what more appropriate site could there be for a statue of the man who first crossed the African continent from west to east just under one hundred years ago? Everything as usual depends on finance and we

have little more than £500 in the Memorial Fund, hardly enough to pay for the casting alone. But another Scot distinguished in another field, our own Honorary Treasurer, Lord Catto of Cairncatto, has now come to the rescue and has trebled the original fund by a personal gift of £1000. I know that you will join with me in thanking Lord Catto warmly for his generous gift which will enable us to commemorate in this way a great man, a great explorer and a most, if not the most, famous Fellow of our Society.

I began this Address with some account of the work of the various Committees through which the Society functions; and described that work by reference to the dual role played by Theory and Practice in the scientific and administrative responsibilities of the Society. I have now only a few moments left before we proceed to the other business of the meeting and I propose to say something of the position of our Society just one hundred years ago. After all, this is Festival year and the Society is doing its best to celebrate worthily in the light of its traditions the centenary of the 1851 Exhibition. How were our predecessors, the Council and Fellows of the Society, occupied then?

The forties of the last century had been a most depressed period for the Society when, in 1851, Sir Roderick Impey Murchison became President for his second term. It was an epoch-making moment for the Society and for its President, who was a distinguished geologist as well as a remarkable man, for under his Presidency, to quote the Society's historian Hugh Robert Mill once more, " The Society became a national institution with wider functions than those proper to a mere association of persons interested in geography and exploration." And that is the shape of the Society today.

The year 1851 also saw geography as a subject with its own section at the annual meetings of the British Association for the Advancement of Science. Here the Society foreshadowed the great part it was to play in the establishment of geography as a subject in its own right; for Section "E", as it came to be called, was not only inspired by the Society, it was entirely organized by it. It was a moment to which our academic Fellows may well look back with gratitude in these days of great and growing departments of Geography in all our Universities.

But this was not the only sense in which 1851 was a prophetic year for our Society. On the close of the Great Exhibition, the Prince Consort, Vice-Patron of the Society at the time, and the Commissioners of the Exhibition, made an offer to a number of learned societies that they unite and move to quarters on the Commissioner's property in Kensington Gore. It was not until 1852 that the matter finally came before the Council. Their answer, even if it shows more strength of character than prophetic insight, is worth recording. "The President," so the minutes run, "was empowered to bring the subject before Prince Albert, the Vice-Patron, and to express to His Royal Highness the unanimous sense of the Council that a removal to Kensington Gore was not compatible with the well-being of the Society."

I have attempted in this last Presidential Address of mine to tell you something of the well-being of your Society today. If I have not said enough to convince you (if, that is, you still need convincing) then I can do no more than recommend that you look around you in this Hall, and in these imposing buildings, and supply for yourselves the answer to the doubts of 1851.

EXPLORATIONS IN THE NEPAL HIMALAYAS

H. W. TILMAN

BEFORE LEAVING KATMANDU in 1949 I asked permission for a party to visit the Annapurna Himal. The Himalayan Committee followed this with a formal application to which a favourable reply came rather late. It was the end of February 1950 before I could begin collecting a party and stores, and with difficulty secure passages for early April. My notion was to take a small party such as explored the Langtang,[1] collecting plants, battering rocks, amending the existing map, and attempting no great peaks. But the Himalayan Committee preferred a larger party in order to begin building up a nucleus of experienced Himalayan climbers such as existed between the two wars.

My party finally included Colonel D. G. Lowndes, our botanist; Major J. O. M. Roberts, a Gurkha officer with experience of Himalayan climbing; Dr. C. H. Evans; J. H. Emlyn Jones; and W. P. Packard, a New Zealand Rhodes Scholar studying geography at Oxford. The last four were climbers but Packard had also a scientific role. I had hoped to survey the north-west corner of our area which is very sketchily mapped, but the only suitable photo-theodolite in England had been earmarked for the Shaksgam party, so that instead of survey work Packard was to inquire into soil erosion and land utilization. Owing to their remoteness Himalayan villages are not likely to reap any practical benefit from this inquiry in our time, but on that account it will be none the less gratifying to our long-term world planners.

As the ship carrying the party and stores was billed to sail on Good Friday I was not surprised when some defect delayed her for a week. Nor was this the only rub. Travelling across India in April is hot, but our party found it hotter than usual by reason of the compartment and some of our kit going up in flames. This meant more delay, so that it was not until May 10, ten days later than we hoped, that we left Katmandu with four Sherpas and fifty local coolies.

When after ten days' marching we entered the Marsyandi valley, we had lost height and were down to 2000 feet; and three days later, at Thonje where the valley turns westwards behind the Annapurna range, the height was only 6000 feet. Like many Nepal rivers the Marsyandi rises north of the main Himalayan crest-line (but not north of the Ladakh range) and cuts through by a deep gorge. Below Thonje the valley is flanked on the east by a great spur projecting 20 miles southwards, carrying Himal Chuli (25,801 feet), another peak of 25,705 and Manaslu (26,658). We had had some frightening glimpses of these peaks but before dismissing them we halted at Thonje for four days while we went to look at the north side of Manaslu. The north ridge of this magnificent mountain is its only approach, but my interest in it soon died for after leading airily over a 25,000-foot bump it dropped a

[1] P. Lloyd, "New British exploration in Nepal," *Geogr. J.* 116 (1950) 172–82.

thousand feet before rising sharply again to the summit plateau in the remotest corner of which stood the summit pyramid. Anyway I was loth to pit an untried party against so great a mountain and yet hoped to find one high enough to test our acclimitization powers and easy enough to offer some hope of success.

We therefore left the peaks of this great spur for better men and went on to seek an objective in the Annapurna Himal which offered several great and

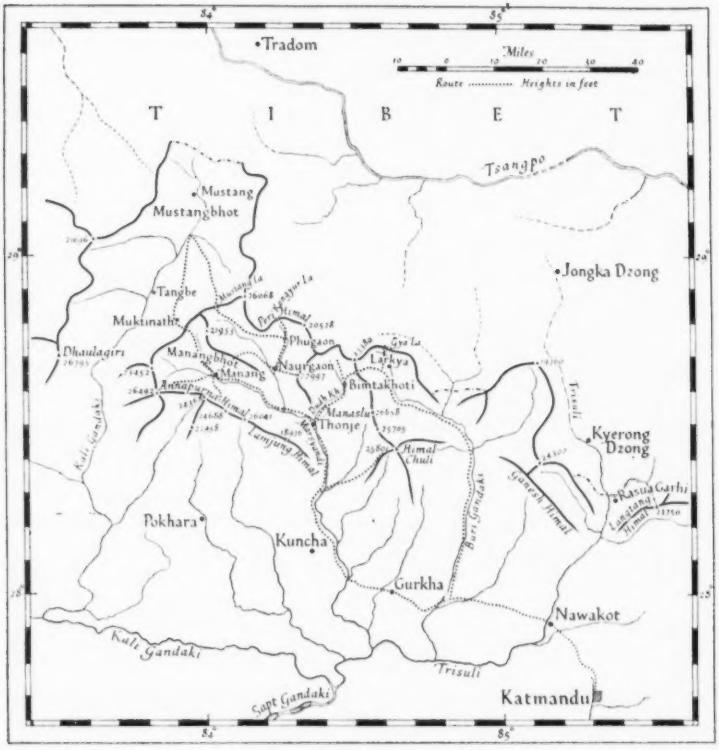


Fig. 1. Western Nepal

glittering prizes. This Himal consists of an east–west ridge over 25 miles long, nowhere lower than 20,000 feet, and with Annapurna I (26,492) at the west end, Annapurna II (26,041) at the east, two peaks of 24,000 odd in between, and others of 22,000 and 23,000 in attendance on the two giants. Nor is this all. There is a southern outlier called Mocha Pochare, or the "fishtail" (22,958) and several good peaks on the north side of the Marsyandi valley; and beyond them is the Ladakh range on the Nepal–Tibet border.

After rounding the corner above Thonje and drawing under the shadow

of the Annapurna massif we noticed a change of climate. Mindful of our dank experiences in the Langtang in 1949 I rejoiced to see the deciduous rain forest, draped in lichen and moss, giving place to pines and juniper, sparsely set on bare earth or gravel slopes. Terraced fields of wheat and buckwheat under irrigation confirmed the lightness of the monsoon rainfall. The appearance of this semi-desert did not please our botanist who had come prepared to be wet but happy amid a wealth of flowers. But above 14,000 feet, where clouds lay constantly during the monsoon, he found an ample variety.

We put our base in a pine-set glade a few hundred feet up on the north side of the valley close to the group of villages which constitute Manangbhot. Most of the range was in view except Annapurna I which the French, though we were unaware of it, were then climbing. We never had a good view of Annapurna I, but two of the French party who crossed from the Kali valley to Manangbhot reported it to be unclimbable from the Manangbhot side.

These villages, lying at about 11,500 feet, are like Tibetan villages—flat-roofed stone houses huddled together and an abundance of *mani* walls and *chortens*. The people are of course of Tibetan race and speak a Tibetan dialect, but they are an unusual kind of Himalayan community. They are great traders who spend the winter months in cities like Delhi and Calcutta, or as far afield as Singapore and Rangoon. They are familiar with boat, train and even air travel; and with the pale-face and some of his less commendable ways. They speak Hindustani garnished with American and wear wrist-watches and Army boots without laces. One of them whom we attempted to photograph retorted by whipping out a camera himself. On the whole they were not pleased to see us and I was not delighted with them. The traveller to remote parts wishes, indeed expects, to find the natives unsophisticated enough to treat him with the respect which he seldom gets at home. At Manangbhot he will be disappointed. Apart from that, they were not eager to sell us food or transport. Our money was little inducement for their winter trading ventures seemed to be lucrative enough for them to devote the summer months to drinking beer and *raksi*. Thrice happy mortals! On these forays into civilization their stock in trade consists of musk pods, *salajit* (literally "rock-sweat," an exudation from rocks used as a sovereign remedy and also in dyeing, printing, and tanning), medicinal herbs, skins and, I imagine, a great deal of impudence.

After prolonged scrutiny we took for our objective Annapurna IV (24,688) which stands on the ridge about two miles west of Annapurna II. In my opinion it was sufficiently lofty, but if the party proved unexpectedly strong it would be possible to carry a camp along the ridge to the foot of the final steep 1000-foot pitch of Annapurna II (26,041).

Cutting out all tedious climbing details, it is sufficient to say that after ten days' work four Europeans and four Sherpas were established in a camp at about 22,500 feet. This was within striking distance of the summit of Annapurna IV which was now the objective. All hopes of going on to Annapurna II had been tacitly relinquished.

We made three attempts. On the first, Evans and Packard turned back after climbing about a thousand feet on account of threatening weather—a threat which was amply fulfilled by a storm which raged until evening. For

the second all of us, less two Sherpas, started rather too early on a cold sunless morning. Within ten minutes Roberts and a Sherpa turned back from numbed feet and an hour later, when neither the sun seemed likely to shine nor the wind to drop, we too retreated. Evans, Packard, and I made the third and last effort, but at 23,500 feet age and altitude brought my faltering footsteps to a halt. I hoped the others would then move faster, but at 24,000 feet or thereabouts Evans too came to the end of his tether. Packard, who was going well, could I think have reached the top had he had a second man.

After a few days rest, four of us set out for an unnamed peak of 22,997 feet which from the top of the Annapurna ridge had looked like a mountain intended for climbing. Roberts, whose feet were troubling him, remained to take over the bird collecting, ably assisted by Lieutenant S. B. Malla of the Nepalese Army who had been detailed to escort us. This new venture was a shot in the dark for we had seen only the upper part of the peak and in the prevailing conditions of mist and drizzle we were not likely to see more. The monsoon had set in about mid-June, when we were on the Annapurna ridge, bringing with it plenty of mist and cloud but not much rain.

We reached the foot of our peak after crossing a 17,000-foot pass to the north, to the village of Naurgaon in the Naur Khola. Through a cloud vista we had seen a way up to about the 15,000-foot level but what lay between that and the summit was anyone's guess. But all went well and after four wet and blind days—one in a rock gully where success hung in the balance—we camped on the edge of a dry glacier above the cloud canopy. Our last camp was at about 20,000 feet and unless we were to be stopped by very soft snow we thought the peak was in the bag. In fact we were foiled by a 1500-foot slope of ice, from which I concluded that the predicting of snow conditions during the monsoon is a task that would puzzle Old Moore.

It was now mid-July and three of the climbers had to go home, barren of achievement but rich, one hoped, in experience. Leaving the botanist and ornithologists busy after their kind I returned with two Sherpas to the Naur valley which we had just left, where I had heard of a pass over to Mustangbhot, an interesting region in the upper basin of the Kali river. This pass, known as the Mustang La, is not shown on the map which hereabouts is extremely vague. At Naurgaon they affirmed, correctly, that the river which the route to the pass crosses would not be fordable until late September; so we went on up the valley to the ultimate Nepal village of Phugaon whence we hoped to force a route along the north side of the offending river to the Mustang La. Under extreme pressure from the headman two Phugaon men volunteered to come, but before setting out we visited another unmarked pass to Tibet over the Ladakh [1] range two days' march to the north. Flocks of sheep and goats carrying salt and rice cross this pass, the Kongyur La, which is over 19,000 feet and even in high summer crowned with half a mile of snow field. On the Tibet side there is said to be no village for five marches. It is a cruel

[1] Professor Kenneth Mason deprecates the use of this name for what he calls "a speculative invention"; and it is certainly confusing to find a Ladakh range cropping up in Nepal. The alternative, "northern crest-zone" as opposed to the "main Himalayan crest-zone," is cumbersome and inconvenient for a range which for some hundreds of miles is the frontier between Tibet and Nepal.

The main Annapurna ridge, Annapurna II in the background

Looking towards the Nup La from near Phalong Karpa

Tangbe village in the upper Kali

pass for animals. Before reaching the comparative oasis of flat snow the track climbs for a thousand feet at the base of a huge cliff from which stones fall with alarming frequency and appalling velocity. The locals who were with us tackled this stretch in short sharp rushes, pausing to draw much-needed breath crouched as close as possible to the foot of the cliff. The foolish flock, meanwhile, took its chance well out in the beaten zone. Those who traffic over such a route by land are surely as worthy of the proud title of Merchant Adventurer as those who traffic by sea.

We found and crossed the Mustang La (18,000) four days out from Phugaon. Having reached its vicinity by our own unaided efforts we turned to our two locals for guidance to the pass itself, only to learn that never in their lives had they been there. At length we spotted a faint trail beyond the river which, now that we were less than a mile from its glacier source, we were able to ford. The pass is crowned with a slab of ice, like spilt icing, such as one meets with in Sinkiang. On the west side we got into trouble in the deep-cut Tangbe nallah which the path, unnoticed by us, had wisely quitted long before, but we finally reached the village of Tangbe a mile from the Kali river. The upper basin of this river occupies the curious salient of Mustangbhot where the Nepal frontier juts north into Tibet. The Kali cuts through the main Himalaya at the great gorge between Annapurna I and Dhaulagiri; and probably through the Ladakh range too, which hereabouts appears to have dwindled to nothing. Looking north to Tibet I could see no hint of a snow mountain across a twenty-mile wide breach. On the map, the river (indicated only by a dotted line) rises not far from the Tsangpo valley; the only explorer to have followed the valley northwards is Hari Ram (1873) one of the Survey of India pundits, but his account of the country between Mustang and Tradom in Tibet is vague.

At Tangbe the river flows in a wide gravel bed flanked by high vertical gravel cliffs carved out of old river terraces; behind rise wildly eroded and weirdly coloured hills, cobalt, slate grey, mauve, chrome, and orange. In this desolate waste, relieved only by the infrequent oasis of some village irrigated by a side nallah, there is never a tree, hardly a shrub or a blade of grass. A day's march north of Tangbe on the west side of the Kali, which is apparently fordable, is Mustang village, the exchange mart for Tibetan salt. The salt is carried by sheep and goats down the left side of this arid valley to Muktinath and thence to Tukucha below Dhaulagiri, whence they return with rice.

We followed this broad highway two or three thousand feet above the river, passing many hundreds of sheep and goats with their little saddle-bags, until in two days we reached the celebrated Hindu pilgrim resort of Muktinath. It lies at about 12,000 feet on the west side of the range which runs north from Annapurna I to articulate with the Ladakh range. It is green and well-watered by springs and there is some pine forest. The wheat had just been cut (at Manangbhot it was not ripe until September) and threshing with flails was—literally—in full swing. Across the Kali, and a little south, Dhaulagiri rises grandly but Annapurna I, the twin bastion on the hither side of the gorge, is hidden. During the few days we had it in view Dhaulagiri seemed singularly free from cloud; and this, together with the early harvest and the treeless aridity of the valley farther north, makes it appear that the

monsoon is of less weight here than at Manangbhot. Each day we were in the valley a thunderstorm brewed over Tibet and swept southwards down the Muktinath range, no rain falling below 14,000 feet. Near our camp I found a rich deposit of the so-called *shaligram*, sacred to Hindus; these are ammonite fossils of the Jurassic *Tethys* sea.

The Muktinath shrine is dedicated to Narayan, an incarnation of Vishnu. Behind it in a courtyard are the 108 spouts from which the pilgrims successively drink of the sacred water; but a more curious thing can be seen hard by in a dilapidated *gompa*. (Muktinath is also sacred for Buddhists.) At one end the usual gilt Buddha sits on a rock shelf, but beneath this natural altar are three small curtained apertures in each of which burns a lambent blue flame, presumably of natural gas. A small stream flows through the centre hole and the flames issues from the rock close enough to the water to justify the native accounts of "burning water." Having taken off their boots the Sherpas prostrated themselves before the altar and examined the flames at their ease. My examination was only perfunctory, for the old crone in charge (a nun) withdrew the curtain with some reluctance for one who so obviously was not seeking The Way. The Sherpas took earth from the floor and a bottle of this holiest of water for their Darjeeling friends.

A pass of 17,000 feet leads to Manangbhot whence, having returned, we all moved up to the head of the Dudh Khola north of Manaslu. This river drains the northern slopes of Manaslu and three glaciers which descend from the Ladakh range. (At this point the two crest zones are in contact.) These three were the only real glaciers we had seen—I mean glaciers with high moraines and several miles of debris-covered ice. Those which descend from Manaslu and from the Annapurna are mere ice-falls which peter out at about 14,000 feet before reaching the valley floor. True, the snout of one almost touches the Marsyandi river opposite Manang village, but except for its last few feet it is an ice cataract. That a 25 mile long range with an average height of perhaps 23,000 feet should have no true glacier on its north side implies little precipitation and a high angle of slope.

Tucked away in the grassy ablation valley of the Dudh Khola glacier at a height of 12,000 feet is Bimtakhoti, a few stone living houses and a rice store. During the summer a constant stream of coolies from lower Nepal bring their 80 lb. loads of rice to exchange for salt at the rate (variable) of 16 measures of rice for 25 of salt. The salt is brought from Tibet by an easy pass over the Ladakh range to Larkya in the next valley to the east, the Buri Gandaki, whence *zos* or sheep carry it over another 17,000-foot pass to Bimtakhoti. We were told that 3000 animal loads are dealt with in a season. What economists call the price mechanism is supposed to govern the rate of exchange, but when Roberts visited Larkya he found the Tibetan merchants trying to enforce a planned economy—planned, that is, in their favour.

Roberts who had now collected enough birds promised to help me to collect a mountain, but while searching for one suited to our moderate powers and dwindling ambitions I carelessly slipped on a boulder and fell a few feet. For five days I had to lie very still until I felt equal to being carried down by the Sherpas to Bimtakhoti where a fortnight more had to be spent recuperating. What with this and the short time left, we had to abandon the climb and

undertook instead the sort of journey the Tibetans call *neko* (a journey undertaken for cleansing from sin and sloth) of which Roberts and I felt the need. We went down the Marsyandi to the Khudi (2500) and then up a long ridge to a lake at the foot of Himal Chuli. To this lovely turquoise lake lying at about 15,000 feet, many pilgrims resort in the summer to bathe ceremonially; in particular those who are desirous of fertility. I bathed unceremonially in its deeper water and thought I was more likely to incur permanent frigidity. We had a good view of the west side of Himal Chuli which looked a difficult and dangerous mountain. On September 20, the monsoon having just stopped, we began the walk back to Katmandu in perfect weather.

The expedition cost roughly the estimated £1800 of which the members found £1050. For the balance we were indebted to the Himalayan Committee, the Percy Sladen Trust, the Godman Fund, the British Museum, the R.G.S., and the R.H.S. We must also record our great gratitude to the Nepal Durbar for their permission and help; and to Sir George and Lady Falconer and Colonel R. R. Proud, who looked after us all in Katmandu. The British Museum reported favourably on the collection of plants and birds which arrived home in good condition thanks to the skill and care of Colonel Lowndes, Major Roberts and, not least, Lieutenant Malla.

The southern approach to Everest

Upon returning to Katmandu early in October I was asked by Mr. Oscar Houston to join him in a journey to Solu-Khumbu for which he had the permission of the Nepal Durbar. This is the district on the Nepal side of Everest from which the Sherpas come. I had had a bellyful of "bummeling" along the valleys of Nepal and this journey would mean a fortnight more each way of valley travel and only a week in the mountains. But the lure was not to be withstood. Mr. Houston's son, Dr. Charles Houston, who had been with me on Nanda Devi and had led a very successful reconnaissance climb on K2, was flying from New York to join us; there was also a well-known American climber Mrs. Betsy Cowles; and another American, Anderson Bakewell, from the Jesuit College at Kurseong near Darjeeling. With a doctor to heal us, a woman to feed us and a priest to pray for us, we could face the future with confidence. Prayer and Provender, says the proverb, hinder no man's journey.

On October 29 we assembled at Jogbani, the Indian railhead which serves the industries of Biratnagar just over the Nepal border where there are jute, cotton, and sugar mills, a sawmill and a match factory, mostly owned and managed by Indians and run with Indian labour. We made another 40 miles through the *terai* on a fair road before having to take to our feet for the long climb to Dharan, down into the Tamur valley, and up again to Dhankuta at 4500 feet. This is the capital of Dhankuta district and the residence of the Governor, one of the Rana family, who very courteously provided us with an escort and an itinerary. Both are needed; for though in remoter Nepal they are not opposed to strangers, they are not used to them. As for the route, it was seldom that indicated on the map which is in need of revision.

From Dhankuta we dropped to 1000 feet in the Arun valley, which we

followed for three days before crossing the river by a ferry (dug-out canoes) and turning westwards. Three passes between 10,000 and 11,000 feet had to be crossed before we reached the Dudh Kosi valley three marches below Namche Bazar. We were now in Khumbu, Solu lying west of the river, and since crossing the first pass the numerous *mani* walls and *chortens* showed that Hinduism had been left behind. It is a matter of altitude rather than region; for one seldom finds Gurkha people living above 8000 feet nor any of the Tibetan-like peoples below it. Before climbing steeply out of the valley to Namche Bazar (11,000) we crossed the Dudh Kosi several times; it seemed a remarkably small river for one that drains not only the Everest

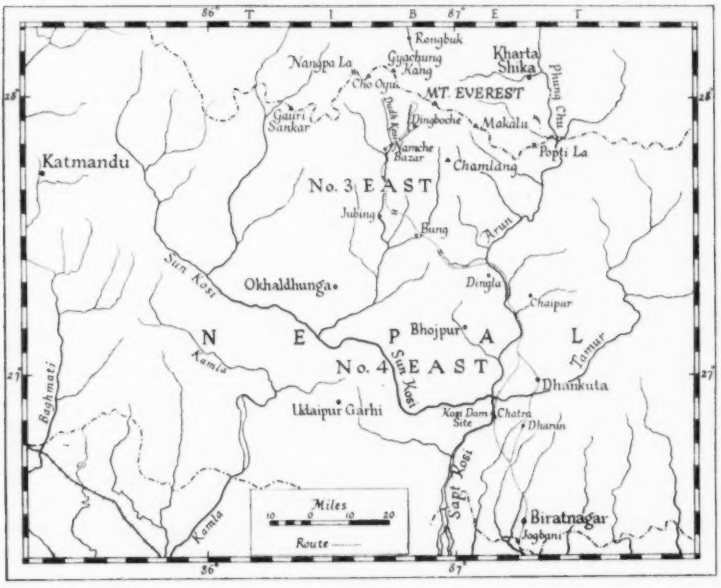


Fig. 2. Eastern Nepal

group but also that of Cho Oyu (26,750), Gyachung Kang (25,910) and an unnamed peak (25,720) between them. It is well bridged by wooden cantilever bridges which seldom need to span more than 20 yards. In November of course the rivers are low, but the summer rise of the Dudh Kosi appeared to be not much more than three or four feet.

At Namche there are about 30 neat detached houses and little cultivation. I imagine the people live by the salt and rice traffic which is carried on over the Nangpa La (19,000) to Tingri Dzong and Rongbuk. Some six miles up the valley from Namche along a rideable track is the monastery of Thyangboche, a small counterpart of Rongbuk monastery on the other side of the mountain. Everest, or rather Lhotse, which the monks call indiscriminately Chomo-lungma, fills the head of the valley. Sited on a grassy

saddle, surrounded by birch and firs, and commanding glorious mountain views in all directions, the white-washed monastery appears far less austere than stony Rongbuk. Within too it is less austere, for at Thyangboche they fortify their guests with "lama's milk" (*raksi* flavoured with cloves) before breakfast.

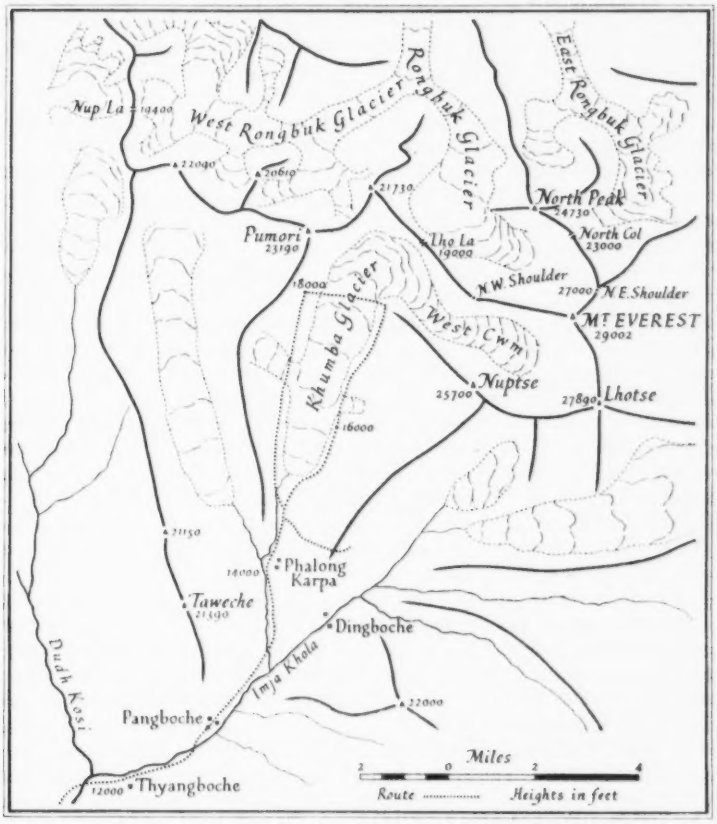


Fig. 3. The southern approach to Everest

Leaving the others at this extremely congenial sanctuary, Charles Houston and I went on up the valley and then northwards up the Khumbu glacier to within four miles of the Lho La where we camped. There are two main glacier valleys, one which begins east of Lhotse (Pethangtse, like Makalu, lies in the Arun basin), and this Khumbu glacier which is fed from the West Cwm and the ridge running from the Lho La to Pumori. The glacier, which has pinnacles like the Rongbuk, is about a mile wide and possibly six miles

long. According to the locals the monsoon is as heavy as in Sikkim [1] and the lichen-draped trees lower down bear this out. Yet the glaciers, like the river, seem small for their parent mountains; and to the inexpert eye there is no sign of glaciation having ever extended more than four miles below the present snout. The glaciers are half the size of those on the Tibet side, one reason being that they start 2000 feet lower down. Both the south face of Everest and the long Nuptse-Lhotse ridge running parallel to it are too steep to hold snow; and the high summer temperatures, increased no doubt by this great mass of south-facing rock, give any snow which falls little chance of turning into glacier ice.

The West Cwm, into which we should have gone but did not, is a mere slit which terminates in an ice-fall close to the Lho La. Even from a hummock of about 18,000 feet on the west side of the Khumbu glacier we could not see the head of the Cwm formed by the airy col between Lhotse and Everest, the lowest point of which is at 25,850 feet. Seen from due west across a precipitous face, the rock of the south ridge looked so steep that we dismissed the hope of there being a route. But were we looking at the true edge of the ridge or merely at some protruding buttress of the south face? For pictures taken in 1921 from the Kama glacier to the east show the south ridge to be broad, snow covered, and lying at a less formidable angle. There is no reaching this high col from the east, so there remains the one small possibility of reaching it from the head of the still unseen West Cwm. Personally, I think the chances are all against finding an easy snow ramp leading from this comparatively low glacier to this appallingly high col; and the Cwm would be an unpleasant and dangerous place for an advanced base. Thus, although I should not like to write off the south side of Everest [2] without looking into the West Cwm, I think it is safe to say that there is no route comparable in ease and safety, at any rate up to 28,000 feet, to that which we already know so well.

It is idle to discuss the approach via Nepal if there is no route on that side; nor is it of any use as a means of approach to Rongbuk, for there is still the political barrier in addition to the 19,000-foot physical barrier of the Nangpa La. Until 1949 the Nepal Himalayas were more difficult of access than Tibet and the present freedom of access may be withdrawn. In that year the Himalayan Committee applied for permission to send a party to the south side of Everest, but the Nepal Durbar suggested the Langtang which was accepted thankfully. The Nepal route to the mountain is a week shorter than the Tibetan; but instead of mules one would have to employ large numbers of coolies for whom food en route is not readily obtainable. No acclimatization would be acquired by the party; and against the colds and sore throats due to Tibetan dust and wind there is the more unpleasant risk of malaria.

[1] Precise figures should soon be available from the snow and rain gauges left by Dr. Bannerjee, of the Indian Meteorological Service, at Namche Bazar and Chaunrikharka, a village lower down, in 1948.

[2] The possibility of an assault on Everest from the south is the object of the Everest Reconnaissance Expedition 1951, led by Eric Shipton and sponsored by the Himalayan Committee of the R.G.S. and the Alpine Club.

DISCUSSION

Evening Meeting, 19 March 1951

Before the paper the PRESIDENT (SIR HARRY LINDSAY) said: Ladies and gentlemen, I have very great pleasure in introducing to you this evening Mr. H. W. Tilman. He is not only an old friend of the Society, having been a Fellow since 1935, but he has been making expeditions and exploring in the Himalayas since, I think, 1934. He has, in all, made something like ten expeditions there and he is going to talk to us this evening about the Nepal Himalayas.

Mr. Tilman then read his paper

The PRESIDENT: Thank you very much indeed. I may say that I myself spent five or six of the most exacting months of my life on the lower reaches of the Gandak river, but many thousands of feet below where Mr. Tilman was. We have present with us this evening both Colonel Lowndes and Mr. Packard.

Colonel D. G. LOWNDES: As Major Tilman has told you I had the great good fortune to be asked to accompany his expedition to Nepal; to collect plants and specimens for the British Museum and, if possible, seeds for the Royal Horticultural Society. I was also asked to supervise the collecting of birds by an Indian collector who was to join the expedition, but that was a secondary responsibility. In fact, the bird collector failed to materialize, and it was with great relief that I found that Major Roberts would take over.

We reached Manangbhot, the area in which I was to work, at the end of May and the first view of the promised land was a great disappointment to me. It was arid in the extreme. There was hardly a blade of grass to be seen on the lower slopes and the few birch trees on the higher slopes were not even in leaf. This fact was however a blessing in disguise for me, because I had no skilled help of any kind and had it been an area with a normally heavy monsoon rainfall and more luxuriant vegetation I should have been unable to cope with the material available.

Our base camp was at about 12,000 feet and it was not until about the end of June that any considerable quantity of flowers became apparent. Then, at a height of 14,000 feet, I found flowers in quantity and, in July and August, there was a wealth of flowers in the side valleys above that level. Those of you who have been in high mountains will know what a wonderful sight alpine flowers are.

The collections I was able to bring back have not of course been worked out yet or fully named at the British Museum. The few that have been examined have not revealed any species new to science, but one *Primula* had not been seen for 60 or 70 years, and then it had been collected several hundreds of miles farther east in the Himalayas. An interesting point brought out by this expedition and the one of the previous year is that some of the plants found in Nepal by collectors sent out between the wars at the instigation of Lord Wigram, by arrangement with the Maharaja, have a very circumscribed area. Certain of the flowers we know as Blue Poppies (*Meconopsis*) are apparently very local in distribution.

I was also able to collect a small number of seeds. They are now just getting to the interesting stage, the people who are trying to grow them have masses of seed pans full of small seedlings that should, with luck, introduce a number of new flowers into our garden and reintroduce some others.

Major Roberts was able to make a very satisfactory small collection of birds and brought back nearly 200 bird skins to the British Museum, where they are being studied. There again I believe there is nothing of startling interest but valuable knowledge will be obtained about the distribution of species. I also

managed to collect a small number of butterflies for the Museum but found that chasing butterflies at over 10,000 feet was not at all in my line! However I had with me as factotum a Gurkha youth aged about 16 or 17 and, after he had passed the stage of attempting to drive butterflies into the net, he became seized with enthusiasm to catch them himself; and that just suited me.

Mr. W. P. PACKARD: I had a double function, both mountaineer and geographer, and luckily the monsoon arranged my time for me. The first part was spent in climbing and the second in geographical studies, more especially on Himalayan land use and soil erosion.

I would almost put soil erosion in inverted commas, for the literature on Himalayan landscapes has suggested this as a considerable problem and to my delight it was not so in Nepal. Villages seemed indeed to have a considerable amount of uncultivated land, not apparently because of accelerated erosion but, as far as I could see, from indifference. Possibly it resulted from a change in climate, though I think this doubtful, or possibly from a change in local population by war or disease.

My journey into the Himalaya had been in itself a reconnaissance of land use and soil erosion problems and I therefore decided to occupy myself in the Marsyandi valley on a comparative study of that area and the effects of physical environment on man's activities. Yet even within the upper Marsyandi valley I found great contrasts and a progression along the valley which was extremely interesting. At Tangbe I found the climate and rainfall of Tibetan Nepal sufficiently mild for two crops in the year; an early crop of wheat or barley, planted generally around February, and one of maize, buckwheat or potatoes planted at the end of the monsoon. Ten miles farther up, where the monsoon apparently penetrated to a less degree, the rainfall was sufficient for only one crop, generally barley or wheat, the altitude and temperature being unsuitable for maize.

There was a marked progression in house styles within the valley. At Tangbe houses were roofed with pinewood, indicative I felt of the much higher rainfall and the lack of suitable materials for flat roofs. Elsewhere, perhaps because of the availability of clay, most of the roofs were flat in the Tibetan style. The headman in Tangbe also had a house almost as big as the other houses put together; in lower Nepal the difference is less marked. Here too the people were concerned not only with agriculture but with the transport of rice to the Tibetan frontier and with a considerable trade in wool, medicinal herbs and, though we did not see it, in minerals such as borax.

Illness compelled me to come back about a month and a half before I had meant to, but I was able to observe the more striking contrasts between Nepal at about 2000 to 4000 feet and the more Himalayan sections I had visited, between 6000 and 12,000 feet. Not only were the people different, being more of Gurkha or almost Indian stock, but the houses and agricultural methods were different too. Rice predominates over the wheat and barley of Himalayan Nepal; and wheat, or sometimes barley or unirrigated rice, is grown before the monsoon. Unexpectedly, the villager of lower Nepal is much more a subsistence farmer, and many of them have travelled widely. I, who had not flown in an aeroplane, was confronted with three people who had done so. The people here are largely concerned with growing rice to pay their taxes or to buy a little cotton cloth; they exchange rice or money for the salt from the more Tibetan areas.

The PRESIDENT: We have had a wonderfully interesting lecture from Mr. Tilman and I am going to ask you to join me in a very hearty vote of thanks to him, not only for his address and for the humour with which he gave it, but for the very beautiful slides, which were his own.

THE FIRST ENGLISH GLOBE: A RECENT DISCOVERY

HELEN M. WALLIS

WHEN A TERRESTRIAL globe of 1592 by Emery Molyneux was discovered in July 1949 in Lord Leconfield's library at Petworth House it was clearly an event worthy of record. The terrestrial and celestial globes which Molyneux put on the London market in 1592 were the first globes to be made in England and the first made by an Englishman.[1] In design and workmanship worthy successors to the globes of Gemma Frisius and Gerard Mercator which Englishmen had used hitherto, they had the merit of being larger than either of these pairs (though still of manageable size) as Robert Hues was careful to point out; and the terrestrial globe, like Hakluyt's 'Principal Navigations,' was designed as a record of English enterprise in maritime discovery. The appearance of the globes was rightly hailed by Hakluyt and John Davis (amongst others) as material proof that English geography could now hold up its head with the leading schools on the Continent. Within two years such eminent geographers and mathematicians as Blundeville, Hood, Hues and Hariot had published books devoted wholly, or in part, to their description.

The globes were presumably made and sold in considerable numbers, for William Sanderson, their patron and financier, spent over £1000 on them. "They are now in the handes of many with whom I have to do", says the pupil in Hood's dialogue [2]; and it must have been with pairs of Molyneux globes that the Warden of all Souls College and Sir Thomas Bodley provided their libraries at Oxford.[3] Even in 1656 William Sanderson's son [4] was able to write that the globes "are yet in being, great and small ones, Celestiall and Terrestriall, in both our Universities and in severall Libraries (here, and beyond Seas)." Envisaging as it seems a large demand Molyneux made, at a cheaper price, the smaller globes here referred to, "that so the meaner Students might herein also be provided for."[5] Nor was it only among geographers and university men that the globes quickly became well known. Not many months after their publication Shakespeare was assuming familiarity with them in his audience, referring to them in *The Comedy of*

[1] MS. Harl. 5208, 50–51. This is an account of William Sanderson's achievements "by a Freind." It describes the globes as "the first soe published in Christendome, for the honor of his countrey, and good of the Schollers, Gentrye and Marriners of the same." Contemporary geographical works support this claim that these were the first English globes, for no earlier English globes appear to have been known.

[2] Thomas Hood, 'The Use of both the Globes, Celestiall, and Terrestriall, most plainely delivered in forme of a Dialogue' (1592), sig. B1^{r}.

[3] Sir E. Craster, *Geogr. J.* 117 (1951) 24.

[4] Sir William Sanderson, 'An answer to a scurrilous pamphlet' (1656), sig. A3^{v}. This reference was kindly supplied by Professor D. B. Quinn.

[5] Robert Hues, 'Tractatus de Globis' (Hakluyt Society, 1889), p. 16; John Chilmead, 'A Learned Treatise of Globes' (1639), sig. B8^{v}.

Errors [1] in terms which suggest that he himself had seen them. At Sanderson's house at Newington-Butts, the globes were presented to the Queen, to whom they had been dedicated, "upon which she was pleased to descant, 'The whole earth, a present for a Prince; but with the Spanish Kings leave . . .' At her second entertainment there, she receiving the Celestiall said, 'Thou has presented me with the Heavens also . . .' "[2]

Such was the fame of the globes in their time. Yet hitherto only two pairs were known to have survived. One is the celebrated and beautifully preserved pair (long considered to be unique) in the possession of the Middle Temple and now deposited on loan in the British Museum; the other, first reported by Stevenson,[3] was in the Hessisches Landesmuseum at Kassel in 1921. The terrestrial globe of this pair cannot now be found however and must be presumed to have been destroyed in the second world war.[4] If so, the Petworth globe can claim to be the unique survivor of Molyneux's terrestrial "great globe" in its original state, for the terrestrial globe at the Middle Temple is dated 1603.

The origin and history of the globes

The forthcoming publication of the globes was first heralded in print in 1589. Writing in the Preface to the first volume of the 'Principal Navigations,' [5] Hakluyt explained that he had contented himself with inserting one of the best general maps of the world only "untill the comming out of a very large and most exact terrestriall Globe . . . composed by M. Emmerie Mollineux of Lambeth." It may be that the publication of the globes was expected before 1592 and was delayed. With Molyneux were associated William Sanderson as patron and financial supporter, Edward Wright and Jodocus Hondius (the elder) as engraver. It was, so Hakluyt tells us, "by the purse and liberalitie of the worshipfull marchant M. William Sanderson" [5] that Molyneux had been "greatly supported" in his profession. Sanderson's son,[6]

[1] Act III, Scene ii, 117–144; in which the kitchen wench is compared to a terrestrial globe: to gain its point this must certainly have been a topical allusion. Significantly, the play was written between 1589 and 1594; and all evidence known hitherto has suggested a date not earlier than the autumn of 1591, and more probably late in 1592 (E. K. Chambers, 'William Shakespeare' (1930), I, 310–311). This allusion, which has not been identified before, thus fixes the date more firmly in the late months of 1592 or in 1593. C. H. Coote noticed the allusion but missed the point of it, since he seems not to have realized the approximate date of the play. ('Shakspere's "New Map," ' Series 1, No. 7, *Transactions of the New Shakespeare Society*, 1878, Part 1 for 1877–9, VI, 96.)

[2] Sir William Sanderson (1656), sig. A4v.

[3] E. L. Stevenson, 'Terrestrial and celestial globes' (1921), p. 195.

[4] One hope remains that the globe still survives. It may be in one of various chests in the cellar beneath the ruins of Kassel Art Gallery. If so, it will be accessible only if the gallery is rebuilt, an eventuality which cannot be foreseen. For this and all other information on the globes at Kassel I am indebted to Dr. Kirchvogel of the Hessisches Landesmuseum.

[5] Richard Hakluyt, 'Principal Navigations' (1589), preface.

[6] Sanderson (1656), sig A3v. As a recognition of his achievement the bearing of Sanderson's Crest was advanced by the Queen's command, with the addition of a globe terrestrial and the motto *Opera Mundi*, to him and his heirs for ever. Sig. A4v. The crest is displayed on the globes. On the terrestrial it is set between the addresses to the Gentle Reader, in Latin and English, written by Sanderson himself.

referring to "the English great Globes," writes that "when that excellent Mathematician Wright, and the rare Artizan Molineux, could not finde any other person, willingly to disburse above 1000 l. to perfect them, my father did." One of the most active of London's merchant-adventurers, Sanderson had been the promoter also of John Davis's voyages in search of the North-west Passage and of the "severall Adventures into Virginia." [1] Hondius, Molyneux's other collaborator, is known to have been living in London at about this time (1583–*c.* 1593). C. H. Coote [2] believed Hondius's hemispherical world map (entitled *Vera Totius Expeditionis Nauticae Descriptio D. Franc. Draki*) to be based on Molyneux's terrestrial globe, but a comparison of the two reveals too few similarities to support this contention. Hondius's world map of 1608 on Mercator's projection, has however a number of legends, names and outlines which must have been directly copied from the globe.

Of Molyneux himself little has been discovered. He was resident in Lambeth, is believed to have been a mathematician and mathematical instrument maker and was, in Hakluyt's words, "a rare Gentleman in his profession, being therein for divers yeeres." [3] His name suggests that he was well connected; for the Molyneuxs were a distinguished family of Norman descent but there is no Emery Molyneux amongst them.[4] He was not the E[dmund] Molyneux who was secretary to Sir Henry Sidney in Ireland, 1569–1571 (an identification which has been made). Nor is contemporary literature much more revealing of his life and origins, since he figures in it almost exclusively as the author of the globes. In 1591 Simon Forman, the notorious quack, referred to (and explained why he rejected) Molyneux's offer to test Forman's claim to have discovered a method of determining longitude.[5] In 1605 Richard Polter,[6] one of the "late principall Masters" of the Royal Navy, described Molyneux as the only man since Robert Norman to be expert in the "touching" of needles and compasses. Such are the few certain references to Molyneux in any other rôle.[7] Only one other work bears his name: an engraving of the Mariner's Compass,[8] signed *Emer. Molle* 1623. *Thomas Jenner excudit.*[9] A second work with which Molyneux may well have been associated is a rutter (or route book) in MS., now in the British Museum (MS. Sloane 2292). It gives sailing directions

[1] MS. Harl. 5208, 51.

[2] Dictionary of National Biography, vol. 9, under Cavendish, 362a.

[3] 'Principal Navigations' (1589), preface.

[4] His name does not appear in the "Visitations" of those counties where the Molyneuxs were prominent among the gentry, nor in Gisborne Molineux's 'Memoir of the Molineux Family' (1882), in which are assembled all the facts concerning these Molyneuxs and records of lesser known Molyneuxs. It is possible that Molyneux's name originally was Molle and that he assumed the more elegant name for professional reasons.

[5] Simon Forman, 'The Groundes of Longitude' (1591), sig. Biii^{r}.

[6] Richard Polter, 'The Path-way to perfect Sayling' (published with additions, 1644), p. 22.

[7] These two references by Forman and Polter were first noted by Professor E. G. R. Taylor, 'Late Tudor and early Stuart geography' (1934).

[8] Society of Antiquaries, Broadsides III, 207.

[9] Reference supplied by Dr. A. M. Hind.

for Brazil and the West Indies and for navigation between Spain and New Spain, and was evidently derived from Spanish sources and corrected by English seamen.[1] The MS. ends with the following note:[2]

> This whole rutter hath been examined with a copy of John Douglas which was written out of S^r^ Water Raleghes had of Cap. Parker.
>
> Those notes that are written on the blancke pages are such readinges as are in that copy & where lines are stroked without note of diverse readings they are words of my copy more then in his. My copy was had of E M .1590. & this was examined .1595. & the last part fro page 35. was more then was in my copy. T. H.

From the evidence of the handwriting,[3] T. H. has been identified, beyond all possible doubt, as Thomas Hariot. It may be conjectured that E. M. was Emery Molyneux. This is the sort of information that he would use for his globe; the MS. (of which he may have been the copyist[4]) might well have been one of his sources for the *descriptiones aliorum*, which helped him to determine the width of the Atlantic, to draw the West Indies, and to illustrate Drake's voyage to them in 1585–6. By 1590 Molyneux was already establishing his reputation, as the references to him by Hakluyt and Simon Forman show, and in 1590 Hariot was well known as a surveyor, mathematician and geographer; he had made his name by his book 'A brief report of the new found land of Virginia' (published in 1588). That the two should be acquainted and cooperating with each other is not at all unlikely.

It is certain that Molyneux was personally acquainted with other men eminent in the ranks of English geographers and explorers. He knew Edward Wright, who was evidently associated with the making of the globes[5] and who used the terrestrial globe as one of his sources for "the new map" of the world of 1599 and 1600. (For this reason it has often been attributed to Molyneux.) That Molyneux knew Hakluyt is suggested by Hakluyt's knowledge of the globes in 1589. He probably knew Raleigh and he certainly knew John Davis who evidently introduced him to Sanderson. Davis claimed to have been "the onely meane with master Sanderson to imploy master Mulineux therin" (that is, in his "many excellent practices").[6] A further piece of information about Molyneux, which has hitherto been overlooked, comes from the globe itself. Explaining in a legend, that he has purposely omitted polar lands and has corrected the distance across the Atlantic between the Lizard and Cape Race (in Newfoundland), Molyneux

[1] Monson, 'Naval tracts,' 2, pp. 334–5.

[2] MS. Sloane 2292, fol. 40.

[3] Mr. R. A. Skelton reports that in MS. Add. 6789, one of the Museum volumes of Hariot MSS., are two letters in the same hand as the note in the Sloane MS. and signed with the same initials written in exactly the same way. These letters are addressed to the writer's physician and are bound up with a number of letters addressed to Hariot at Syon House, c. 1610–1616.

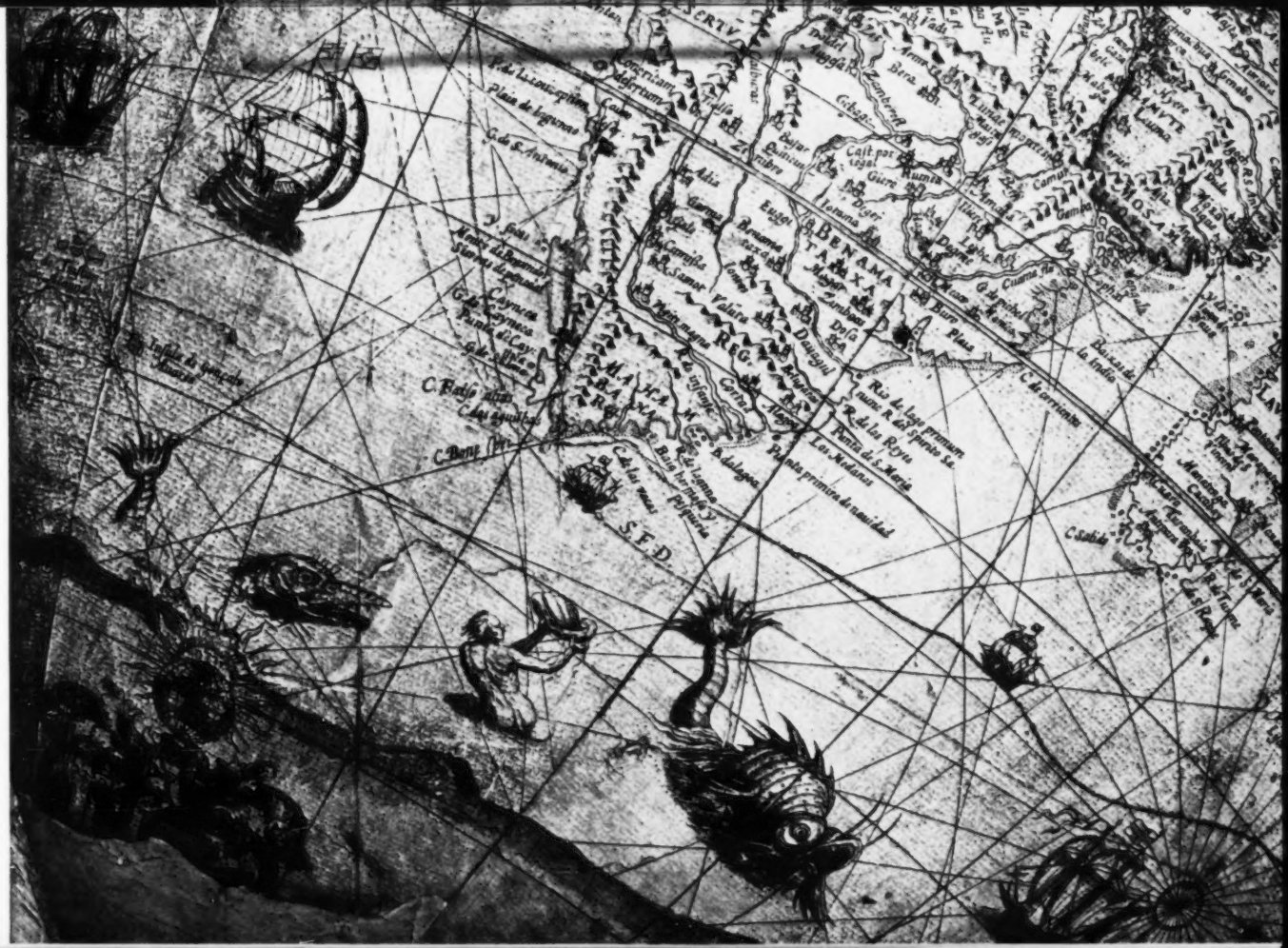
[4] This cannot be proved or disproved as no holograph by Molyneux has yet been found.

[5] Sir William Sanderson (1656) sig. A3^v^.

[6] John Davis, 'The Worldes Hydrographical Discription' (1595) sig. B5^v^.

Phot. British Museum

Petworth globe: title legend



The Cape of Good Hope on the Petworth globe

Phot. British Museum

concludes "Quod equidem effeci tum ex meis navigationibus primo, tum deinceps ex felici illa sub clariss. Fran. Drako ad Indos Occident. expeditione, in qua non modo optimas quasque aliorum descriptiones, sed quidquid mea quantulacumque, vel scientia vel experientia ad integrum hoc quinquennio praestare potuit, ad hujus operis perfectionem comparavi . . ." [1] ("I have been able to do this both in the first place from my own voyages and secondly from that successful expedition to the West Indies under the most illustrious Francis Drake: in which expedition I have put together not only all the best delineations [2] of others, but everything my own humble knowledge or experience has been able to furnish in the last five years to the perfecting of this work.") This shows that Molyneux had sailed on certain voyages; and it suggests that these did not include Drake's West Indies voyage of 1585–6.[3] It suggests further that, like Drake's return route,[4] Molyneux's voyages were in the North Atlantic, thus providing evidence for the width of the ocean in northern latitudes. Other pieces of evidence combine with these facts to suggest that Molyneux may have sailed with Davis on one or more of his Arctic voyages undertaken in the years 1585, 1586 and 1587. It would explain not only Davis's acquaintance with Molyneux and his introduction of Molyneux to Sanderson, but also Molyneux's great care in the delineation of Davis's discoveries, for which evidently he had the help of Davis himself or his charts. The delineation won Davis's complete approval, for he wrote ". . . how far I proceeded and in what fourme this discovery lyeth, doth appeare upon the Globe . . ." [5] He might not think perhaps of mentioning the fact that Molyneux had sailed with him on the expedition (if indeed he did). The evidence is admittedly tenuous and perhaps nothing more definite will be uncovered. But it is almost certain that the one voyage already doubtfully attributed by Markham to Molyneux (for quite different reasons), namely Cavendish's circumnavigation, is not one of those on which he did sail.[6] Nor is it likely that Molyneux sailed with Martin Frobisher on any of his voyages to the north-west in 1576, 1577 and 1578, since he made the mistake of drawing Frobisher's discoveries in the southern part of Greenland. This mistake arose probably from his attempt (in which he might have been aided by Davis) to reconcile the reports of Frobisher's discoveries with Davis's. The maps [7] of those who took part in the voyage or were associated with it, and the various written accounts, leave no doubt that Frobisher and his companions correctly located their discovered strait to the north of the American continent, mistaken though they were in other respects. How they

[1] For help in the reading of doubtful words and in the interpretation of this passage, I am especially grateful to Miss D. H. F. Gray of St. Hugh's College, Oxford. I am indebted also to Mrs. M. Smith and Miss C. Clark.

[2] *Descriptio*—delineation, map or description (Lewis and Short).

[3] An "Anthony Mollineux of London, Gentleman" did sail with Drake in 1585, and died on the expedition in 1586 (Gisborne Molineux 'Memoir' (1882), p. 142).

[4] The Primrose Log (in Julian S. Corbett, 'The Spanish War' (1898), p. 27) shows that on their return they directed their course to Newfoundland and so homeward.

[5] Davis (1595), sig. $B5^{v}$.

[6] See p. 283.

[7] See the two maps in Settle's account of 1577 ('Frobisher's three voyages' (Hakluyt Society, 1867)) and Michael Lok's map in Hakluyt's 'Divers Voyages' (1582).

subsequently reconciled their own discoveries with those of Davis is not known; yet it is doubtful if anyone who had sailed with Frobisher would have placed Frobisher's Strait where Molyneux did.

The month in which the globes were first published is not known. Markham, writing in 1889, alleged that they appeared "in the end of 1592" [1] and gave no evidence in support of the statement. The globes were published not long before Hood (in 1592) published his book on them, as Hood's preface shows, but there is no entry relating to Hood's book in the Stationers' Register. If however the globes were published in the late months of 1592 or some time between January and March, 1593 (1592, Old Style), this would explain why Hues described the globes as "set forth at London, Anno 1593." [2] The record of the Warden's purchase of globes for All Souls, 1592–3, supports this evidence for a late date, since the purchase cannot have been made before November 1592 and is more likely to have taken place some time in 1593.[3]

The authorship and dates of the globes are set out as follows in the addresses to the reader:

Petworth, terrestrial:

ANNO DOMINI / 1592 / Emerius Mulleneux
Angl.' / Lambithiensis Author. / Iodocus
Hondius Flan. / Coelator.

Middle Temple, terrestrial:

ANNO DOMINI / 1603 / Emerius Mulleneux
Angl.' / sumptibus Gulielmi— / Sandersoni
Londinē: / sis descripsit.

Middle Temple and Kassel, celestial:

Iodocus Hon: / dius Flan. sc. / 1592.

The index of 1816 for the Hessisches Landesmuseum reports the terrestrial globe by W. Sanderson (*sic*) as 1593 in date. It is possible that the "3" is an error of the pen, but whether 1593 or 1592 is correct could only be determined from the manuscript of the index, which has been lost. It must not be assumed that, because none has survived, no terrestrial globes were published bearing the date of 1593. Small textual alterations, which might have included an alteration of the date, were certainly made on the terrestrial globe after 1592 and before the main revision of 1603.

The nature of this main revision has been misrepresented. Newton and Coote in 1879,[4] and Markham in 1889 [5] asserted that the date of the Middle Temple terrestrial globe had been altered with a pen to 1603. But it is clear from the character of the figures that the date has been altered on the copper plate. The globe thus represents a later state. The evidence for the textual

[1] Sir Clements Markham, in Hues (Hakluyt Society, 1889), xxvi.

[2] Chilmead (1639), preface, sig. B1^{v}; Hues (1594), sig. gg1^{r}.

[3] The All Souls *Computus*, or bursar's rolls, which contain the entry concerning the purchase, run from All Souls' Day to the following All Saints' Day. For this information I am indebted to Sir Edmund Craster.

[4] *Encyclopaedia Britannica*, 9th Edition, under 'Globe,' p. 682.

[5] Markham in Hues (1889), xxvii.

alterations made between 1592 and 1603 concerns the writing of the names of Drake and Cavendish. While on the Petworth globe the tracks of Drake and Cavendish are generally indicated by their initials, S. F. D. and T. C., the Middle Temple globe has their full names; and wherever Cavendish's name is spelt in full on the Petworth globe, it is spelt *Thomae Candis*, and not *Thomae Candyssh*, as on the Middle Temple globe. Yet it is a curious fact that some fragments of gores used for making the body of the Petworth globe and extracted during its recent repair bear the revised version of Cavendish's name. This alteration of the plate must, therefore, have taken place some time after the printing of the Petworth globe gores, but before the gores were mounted on the body. The Petworth globe must surely have been assembled before 1603, for it seems improbable that the globe would be completed with gores in the first state after that date without incorporating the *geographical* changes which are found in the later state. Map publishers are notoriously conservative it is true; but only two half gores would need to be replaced for the geographical changes are extremely restricted.

These changes affect only the region of Novaya Zemlya in the North-east Passage; the purpose of the revision was the incorporation of Barents's discoveries made on his third voyage of 1596. Though on the Petworth globe only the western part of Novaya Zemlya survives as evidence of the first state, its whole form can be reconstructed with the aid of the map skilfully drawn from the Molyneux globe by John Blagrave [1] in 1596. Novaya Zemlya and six other islands, including "Varon" and "Vaygath" (Vaigats Island), are laid down as an archipelago. To the west of these, and quite distinct from them, Willoughby's Land is represented by a large island whose conjectural coastline is indicated by a dotted line. The revised version of 1603 retains Willoughby's Land. In place of the archipelago, Novaya Zemlya is drawn as a long crescent-shaped island stretching from north to south, a form which it was to retain for many years. Its northern cape displays the hut where Barents spent the winter, and carries the legend "*Het behouden huys*" (the occupied house). That Barents's discoveries should be singled out from amongst the others made between 1592 and 1603 shows the importance attributed to the knowledge of the North-east Passage revealed by his third voyage. Molyneux even omitted the other discoveries made on Barents's third voyage, namely the discovery of "*T'veere Eylandt*" (Bear Island) and of "*Het nieuwe Land*" (Spitsbergen), although Wright had already displayed them on "the new map" of 1599 and 1600. The reason for this is clear: Molyneux evidently copied directly from Gerrit de Veer's map,[2] engraved by Baptista a Doetechum in 1598, and this did not show Bear Island and Spitsbergen. Wright, on the contrary, used as his source the larger and more comprehensive map of the Arctic regions

[1] John Blagrave, 'Nova orbis terrarum descriptio optiẽ proiecta . . . . per Ioannem Blagravum . . . . B. Wright . . . cœlator' (1596), British Museum, Harl. MS. 5935(15); Bodleian, MS. Ashmole 417.

[2] Gerrit de Veer, 'The three voyages of William Barents to the Arctic Regions' (Hakluyt Society, 1876), reproduction.

Because he was working on a smaller scale, Molyneux systematically omitted every alternate place-name on Novaya Zemlya. Thus his source is not at first obvious, especially as "Costint Sarch" is one of the names omitted, and the outline of the strait is omitted with it.

drawn by Barents,[1] engraved by Baptista a Doetechum and published in Amsterdam in 1599.[2]

Description of the globes

With these exceptions, the printed features of the Petworth globe are identical with those of the Middle Temple globe which, together with its partner, was described in some detail in Markham's introduction to the Hakluyt Society's reprint of Hues's 'Tractatus de Globis.' Markham's errors and omissions however justify a further study of the globes.

They have a diameter of two feet one inch or 622 mm. (not of two feet two inches, as Hues recorded).[3] Both terrestrial and celestial globes have two sets of twelve half gores, stretching from the Equator to the polar calottes which begin in 80° on the terrestrial globe but are somewhat larger on the celestial. The engraving is typical of Hondius's work, with its monsters, fishes, and ships on the seas and its fretwork cartouches. Hondius was no doubt given a free hand.

The repairing of the Petworth globe has revealed the construction of its body. The weight is sand. The core is covered by layers of paper in small pieces, over which is laid a coat of plaster about an eighth of an inch thick. On top of this is a further layer of paper over which the gores of the map are pasted. The globes at Kassel are also coated with plaster, but are wrongly reported in the catalogue [4] as being made of papier-maché.

The equipment of the globes is of the usual kind, consisting of a broad wooden horizon circle and a brass meridian ring with an hour circle and index attached. (The hour circle and index are now missing from the Petworth globe.) Both meridian and horizon circles have unusual features. The meridian circle is marked with "parallels" and "climates," a system of division made according to the length of the day and derived from Ptolemy, though extended to include the Arctic regions. In addition to the points of the compass and signs of the zodiac, the engraved paper strips pasted round the horizon circle bear a threefold calendar. In this there are set out, side by side in concentric circles, first the Julian or Common Calendar, with the festivals of the Church year and the dominical letters, second the Gregorian or New Roman Calendar, and third a calendar named thus: '*Calendarium Verum autore I.D. Anglo.*'

According to Blundeville, this third one was "the true Kalendar lately calculated by a most excellent Mathematician and mine old acquaintance *M. Dee* of *Mortlake*, as I coniecture by the letters I. D. set downe upon the said Horizon." [5] It can however be shown almost beyond doubt [6] that

[1] Published by Cornelius Claesz in the second part of the abridged Latin edition of Linschoten's '*Itinerarium*,' reproduction in de Veer (1876 edition).

[2] It is interesting to note that in its western regions Barents's chart was an exact copy of the Molyneux globe. Here is clear evidence of the terrestrial globe's diffusion and authority in Europe.

[3] Hues (1594), sig. A2^{r}, Chilmead (1639), sig. B8^{v}.

[4] 'Beschreibung der Sammlung astronomischer, geodätischer und physikalischer Apparate im Königl. Museum zu Cassel' by A. Coester und E. Gerland (Kassel, 1878), Nos. 21 and 22.

[5] Thomas Blundeville, 'Exercises' (1594), fol. 242^{r}; (1597), fol. 247^{v}.

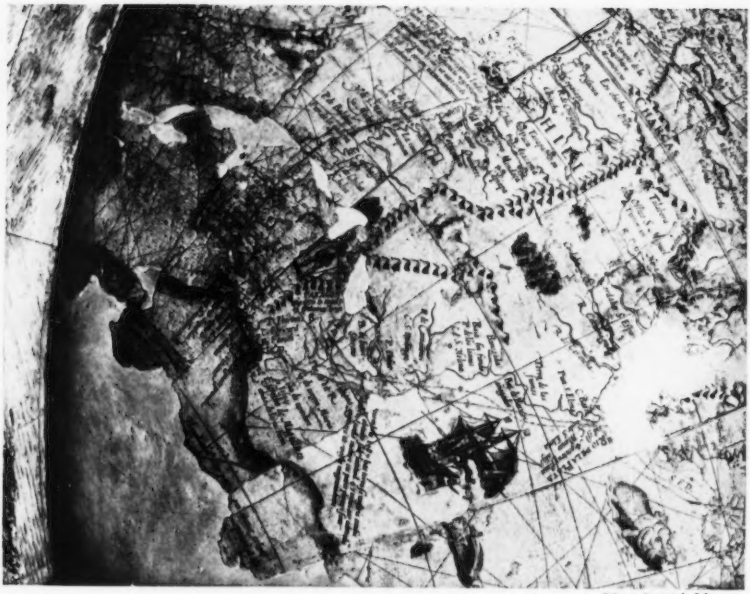
[6] See Appendix to this article.

Phot. British Museum

The Petworth globe, 1592

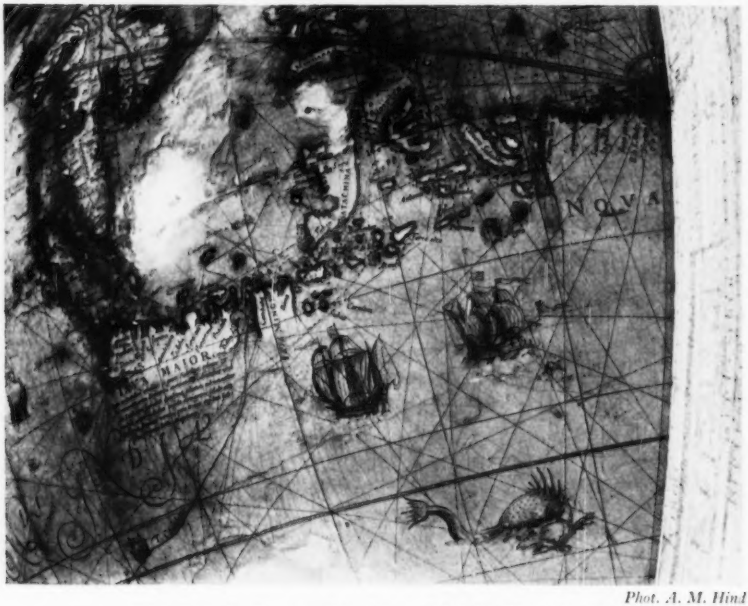
Phot. A. M. Hind

The Middle Temple globe, 1603



Phot. British Museum

South America and the Strait of Magellan: Petworth globe



Phot. A. M. Hind

The East Indian archipelago: Middle Temple globe

"I. D." represented a physician named John Dade, and that Molyneux took the three calendars from a Triple Almanacke which Dade had published for 1591.

The sources and content of the globes are too large a theme to treat fully in this article; here a summary must suffice. The terrestrial globe was "collected and reformed," wrote Hakluyt, "according to the newest, secretest, and latest discoveries, both Spanish, Portugall, and English." [1] Clearly Molyneux used reports of recent travels and voyages and "the newest charts." [2] He rejected unproved theories or indicated their speculative nature by the use of broken instead of solid lines. Thus, unlike Mercator, Ortelius and Peter Plancius, he omitted polar lands because they depended on "no certain authority of writers and on no observation of voyagers." [3] In southern regions he drew the coastline of the hypothetical southern continent with a dotted line. English discoveries in northern waters made in search of the northern passages are shown with a detail and accuracy unsurpassed in any contemporary map.

Full justice is done also to the two most recent and spectacular of English maritime achievements, the circumnavigations of Drake and Cavendish. The globe is the earliest surviving work to show both their tracks. It is remarkable for the care with which Molyneux plotted them and for its incorporation of many items of geographical knowledge revealed either by the voyages themselves or perhaps by documents captured in the course of them. To Cavendish's track there are attached three eyewitness legends, the discovery of one of which led Markham to conjecture that Molyneux may have sailed with Cavendish.[4] But this is most improbable in the light of an error in Molyneux's plotting of the track in the East Indian Archipelago. He draws this to the west, instead of to the east, of the island of Celebes and names that island Batachina. He was following, it seems, a reasonable interpretation [5] of the misleading statement in "N. H." 's account of the voyage that "we ranne betweene Celebe or Batachina and Borneo." [6]

Altogether Blundeville [7] was able to observe many differences between Molyneux's terrestrial globe and Mercator's of 1541, not only in that the former showed many new places unknown to Mercator but also in the names, longitudes, latitudes and distances of places already set down. In these latter details Molyneux differed also from "divers Maps more lately made."

"But as touching the Map of stars . . .", Blundeville concluded, "I do not finde it greatly to differ from that of Mercator, saving that M. Molineux hath added to his celestiall Globe certaine Southern images . . ., and certaine other stars." Molyneux's celestial globe is in fact almost an exact copy of the globe which Mercator had made in 1551, itself modelled on the Gemma Frisius globe of 1537 that Mercator had helped to construct. Hood also had copied

[1] 'Principal Navigations' (1589), preface.
[2] Hues (1889), p. 17.
[3] Legend on the globe, round the North Pole.
[4] Markham in Hues (1889), xxx.
[5] Coote, in 'Dictionary of National Biography,' vol 9, p. 362.
[6] Hakluyt (1589), p. 812.
[7] Blundeville (1594), fol. 242r.

from Mercator in drawing his Star Maps of 1590.[1] The southern images which Molyneux (unlike Hood) added to Mercator's constellations were the Southern Cross and the Southern Triangle. These he located almost exactly as Plancius located them in the southern star hemisphere of his World Map of 1592; yet their longitudes were a matter of doubt, as Blundeville observed and Plancius himself admitted.[2] Later, they were universally displayed to the east of the positions accorded to them by Molyneux and by Plancius. Even Hues,[3] writing his chapters on the celestial globe in 1594, was to expound views (derived from his own observations of the southern sky) that differed markedly from Molyneux's interpretation. Since Molyneux could not have seen Plancius's map (presented to the States General of the Netherlands in April, 1592), before he finished his globe, there is no doubt that Molyneux and Plancius worked from a common source. By his own account [2] Plancius's source was Andrea Corsali, whose work he compared with the writings of Vespucci and of Pedro Medina. It is Corsali's diagram [4] of the Antarctic sky which appears to have been both Plancius's and Molyneux's chief source. They followed it more or less exactly for the Southern Cross and the Southern Triangle and for the Magellanic Clouds. The diagram does not, it is true, give the longitudes of these images; but the position within it of three large stars [5]—intended, presumably, to represent stars of first magnitude—would make its orientation possible. The use of this diagram [6] is sufficient to explain the similarity between Plancius's delineation and Molyneux's. In another respect they differed, as Blundeville noted; the images of *Polophylax* and *Columba Nohae*, which Plancius displayed, were not on the globe. Molyneux, following respectively Corsali and Mercator, represented them by the "certaine other stars" to which Blundeville refers.

No evidence survives of the nature of the smaller globes which Molyneux provided for the "meaner Students." It was a wise provision for, at prices ranging upwards from about £2, the great globes must have been beyond the means of those with slender purses. Evidence of the cost of the globes comes from the Elizabethan records of Oxford University. The Warden of All Souls evidently travelled up to London to buy his globes, and spent £2 8*s*. 5*d*. "for the globes & chamber rent ut patet per billam." [7] Probably his hotel bill amounted to 8*s*. 5*d*. and the globes cost £2. Even so, this was a modest pair compared to those purchased by Sir Thomas Bodley, for he wrote to his librarian: "They cost me very neere 20 li in regard of the extraordinarie guilding and limming that was bestowed upon them." Resplendent in their gilt and paint, Sir Thomas' globes had perhaps some reason for costing nearly ten times as much as the All Souls' pair.[7] It is unlikely that the Warden of

[1] Thomas Hood, 'The Northern and Southern Celestial Hemispheres' (1590), engraved by A. Ryther.

[2] In a legend on the map, translated by Blundeville (1594), fol. 271^{v}.

[3] Hues (1594), p. 36.

[4] Reproduced in G. B. Ramusio, 'Primo volume delle navigationi' (1550), fol. 192^{v}.

[5] They are distinctly larger than the other stars in the diagram in the first edition of Ramusio (1550), but not in that of the fourth (1588).

[6] As it appeared in the first edition.

[7] Craster, *Geogr. J.* 117 (1951) 24.

All Souls would supply his college with the smaller globes, or provide inferior globes with elaborate covers that were drawn up to the ceiling by pulleys and cord; covers which moreover Sir Thomas planned to copy for his own globes.[1] Otherwise, we might have suspected that two pairs so different in price were not both of them pairs of the great globes.[2]

The surviving examples

The Petworth globe has unfortunately suffered much from wear and tear, and the skilful restoration by Mr. Axtell, of the British Museum, has not been able to remedy all its resulting defects. The northern hemisphere is much darkened by dirt and in places the surface is badly rubbed so that it is difficult to read. Some parts of it and larger sections of the southern hemisphere are missing altogether. Fortunately, the part which has suffered greatest damage lies between the parallels of 60° S. and 80° S., a region of lesser geographical interest. Since Molyneux found the southern continent a convenient place for his more elaborate cartouches, some of these are damaged or missing. Where the surface is neither damaged nor darkened however, the Petworth globe is clearer than the terrestrial globe of the Middle Temple pair, both of these globes have a thick coat of varnish now cracked in many places. Whether the varnish was first put on in the course of their repair by J. and W. Newton in 1818 is not known. The globes were almost certainly varnished in 1930 when they were "repaired, polished and adjusted by Messrs. Holland, Hannen & Cubitts, Ltd.," for varnish is believed to have been used in the polishing.[3] Probably the globes were not varnished in Molyneux's time for Dekker's [4] description, in 1609, of "Mullineux his globe, with a round face sleeked and washed over with whites of eggs" is an apt description of the white untouched surface of the Petworth globe. It bears no resemblance at all to the present appearance of the globes at the Middle Temple.

The equipment of the Petworth globe is no better preserved than the globe itself. The horizon circle has lost much of its paper, but enough is left to show that it is similar to the horizon circles of the Middle Temple globes. The stand and the meridian and horizon circles were found detached and have been restored by Mr. Axtell; all the wood is badly worm eaten. A comparison with the Middle Temple globes shows that the stand is less elaborately carved and in this respect it is more like the globes at Kassel; but these have only four legs while the three globes in England have six.

Dr. Kirchvogel reports that the upper surface of the celestial globe at Kassel is much darkened and in some places has abrasions; otherwise it is well preserved but there is no paper on the horizon circle. The terrestrial globe was reported as damaged in the catalogue of 1878.

One can only conclude that the globes of the Middle Temple have profited by finding what Markham called "almost a burial place" in its library.

[1] G. W. Wheeler (editor), 'Letters of Sir Thomas Bodley to Thomas James' (1926), Nos. 6 and 7.

[2] In 1679 Joseph Moxon was advertising twenty-six inch globes at the price of £20.

[3] This information is kindly provided by Mr. H. A. C. Sturgess, M.V.O., Librarian and Keeper of the Records at the Middle Temple.

[4] Thomas Dekker, 'The Gull's Hornbook' (1905 reprint), p. 19. Dr. A. M. Hind found this reference and pointed out the relevance of the description to the Petworth globe.

Certainly they owe to this fact their survival as almost perfect geographical documents. The Petworth globe pays the penalty for an eventful history, yet it gains thereby a further geographical interest.

Lord Leconfield, its owner, is a descendant of the Percy family; and family tradition has it that this globe was given to Henry Percy, ninth Earl of Northumberland (known, because of his interest in the occult, as the "Wizard Earl") by Sir Walter Raleigh while they were both prisoners in the Tower of London.

Raleigh had good reason for a personal interest in Molyneux's terrestrial globe beyond that natural to an explorer, scientist and historian. He must have been Molyneux's source for the discovery of the Solomon Islands, the details of which he had from Pedro Sarmiento de Gamboa,[1] for it is to Sarmiento, and not to Mendaña, that the discovery is attributed by Molyneux. Raleigh's financing of the colonizing enterprise to Virginia is referred to in a legend on the globe. He knew William Sanderson well; in 1571 Sanderson had married Raleigh's niece and in 1594–5 was acting as Raleigh's financial adviser for the Guiana expedition of 1595. Sanderson claimed to have raised most of the money for it,[2] and these transactions were, in 1611–1613, the subject of a lawsuit between them.[3] Further, that Raleigh did own globes is suggested by the globes in some of his portraits,[4] and is proved by the terms of the royal warrant (of 4 November 1618)[5] "to Sir Thos. Wilson to seize all the books, globes, and mathematical instruments belonging to the late Sir Walter Raleigh . . . which could be of small use to his surviving wife . . . the books to be left where they are, but all the globes and instruments delivered to the King."

Northumberland also had globes in his library in the Tower. If the Molyneux globe was originally his, no doubt it was one of the globes which, together with retorts, crucibles, alembics, zodiacal charts and human skeletons, were removed from Syon House to the Tower.[6] If the globe was indeed Raleigh's, his gift of it to Northumberland, perhaps in 1616, seems fitting; for in that year Raleigh was released to conduct the expedition to Guiana. He left his old friend and ally to continue his life sentence in the Tower with all hope now abandoned. If formerly Raleigh's, the globe thus escaped the fate of Raleigh's other globes, for the predatory Sir Thomas Wilson had, by 7 November 1618, already seized all Raleigh's mathematical and sea instruments for the Lord Admiral.[7] In 1621 however, Northumberland had the

[1] In the summer of 1586 Sarmiento, who had been taken prisoner on one of Raleigh's ships, was brought to London and entertained as Raleigh's guest for several weeks. Markham first noticed this evidence of a connection between Raleigh and Molyneux. Hues (1899), xxx.

[2] John W. Shirley, "Sir Walter Raleigh's Guiana finances," *The Huntington Library Quarterly*, 13 (1949); also MS. Harl. 5208, 50.

[3] Shirley (1949), 59.

[4] T. N. Brushfield, "Raleghana," in 'Devonshire Pamphlets, Part VI': *Transactions of the Devonshire Association for the Advancement of Science, Literature & Art*, 36 (1904) 181–218.

[5] C. S. P. Dom. 1611–18, No. 71, p. 590.

[6] G. Brenan, 'A history of the House of Percy,' 1902, vol. 2, p. 167.

[7] C. S. P. Dom. 1611–18, No. 74, p. 591.

good fortune to be released after sixteen years' imprisonment. He was ordered to retire, not to his favourite residence Syon House but to Petworth, a place "which he had never cared for and rarely visited," and he was confined to its "precincts," that is, to within a radius of thirty miles.[1] After a few months he was allowed to return to Syon for certain periods, but after 1622 Petworth remained his principal residence. To Petworth therefore his globes, books and scientific appliances were carried from the Tower, with considerable difficulty along the muddy Sussex roads.

There is therefore circumstantial evidence for the family tradition; whatever the truth, it is probable that the globe spent many years in the Tower which had then become almost an academy. In Lingard's words it was Northumberland "the Maecenas of the age" who "converted that abode of misery into a temple of the Muses." [2] Among the scholars he employed were his "Three Magi," Robert Hues, Thomas Hariot and Walter Warner. As respectively author of and contributor to the '*Tractatus de globis*.' Hues and Hariot were of course closely associated with the Molyneux globes. Hues had dedicated the work to Raleigh. Even the aged and feeble John Dee came to visit his "brother wizard" (it may well be to discuss the occult rather than the exact sciences). Raleigh shared in the teaching of these men, and he and Northumberland frequently exchanged visits. Raleigh indeed received from his scholarly companions so much help—which he openly acknowledged—in his writing of 'The History of the World,' [3] that unfair critics accused him of plagiarism, of borrowed plumes of learning. In general, asserted Ben Jonson, the best wits of England were engaged in the production.[4] Hariot was Raleigh's chief adviser on matters of geography; [5] and since the work contained many geographical allusions—for it was much more than a chronological survey of events in ancient history—both men must often have had need to consult an atlas or a large globe.

Altogether, it would be remarkable if the first English terrestrial globe had not a place in the libraries of Raleigh and Northumberland for their own use and for their teachers'. If there was such a globe, then it was the Petworth globe; for this alone would explain why a globe acquired before 1622 is now to be found not at Syon but at Petworth.[6] Northumberland would not be likely to move a Molyneux globe from Syon to Petworth after 1622.

It is probable that the Molyneux globes of the Middle Temple were acquired on publication,[7] that is, in 1603. Markham's conjecture that they were part of the bequest of Robert Ashley in 1642 is not supported by any

[1] Brenan, p. 200.
[2] Brenan, p. 165.
[3] Sir Walter Raleigh, 'The history of the World' (1614).
[4] William Stebbing, 'Sir Walter Raleigh' (1891), p. 274.
[5] Stebbing (1891), p. 273.
[6] An inventory of all the goods at Petworth in 1632, made shortly after Northumberland's death, lists one large globe and two small ones and "one very large globe white not perfited." This last entry may well be a reference to the Molyneux globe whose appearance it strongly suggests.
[7] This was the expressed opinion of the late Master, J. Bruce Williamson, communicated to me by Mr. H. A. C. Sturgess, whose help in this and other matters is gratefully acknowledged.

available evidence and the globes are not mentioned in Ashley's will. No doubt Markham's theory was in his own view the most reasonable answer to the curious question (as he saw it) how globes, which would have been so valuable to geographical and naval students, had found a resting place among lawyers.[1] But the interests of members of the Inn were less narrowly confined to law than Markham supposed. Raleigh, Hawkins, Frobisher, Drake and the elder Richard Hakluyt (the Lawyer) had all been Middle Templars. In 1603 only Raleigh was still alive, and since 1602 he had been a prisoner in the Tower; but no doubt the Temple still retained its geographical interests. Shakespeare's *Twelfth Night*, which was performed in the Middle Temple Hall on 2 February 1602, assumed that it did; for the play contained a reference [2] to "the new map with the augmentation of the Indies" (Wright's map),[3] and a probable reference [4] to Barents's voyage in the lines: "You are now sailed into the north of my lady's opinion; where you will hang like an icicle on a Dutchman's beard . . ." That the play was written in anticipation of an audience of Middle Templars (or of those acquainted with their affairs, including probably the Queen) is shown by the intertwining of one of its main themes—the attack upon Puritanism—with allusions to recent stirring events at the Temple itself.[5]

The Molyneux globes at the Hessisches Landesmuseum at Kassel have descended (so it is reported) from the astronomical collection of Landgrave Wilhelm IV of Hesse who was a well-known figure in the history of astronomy. He granted an annual pension of a hundred florins a year to Carolus Clusius, the Flemish botanist, who had geographical interests and was a friend and correspondent of Abraham Ortelius.[6] As Wilhelm died in 1592 it is possible that the globes were purchased after his death by his son and successor, Landgrave Moritz of Hesse, who continued his father's collections. So far as is known the globes are first mentioned in the index of the Mathematische Kammer of the Fürstliches Kunsthaus in Kassel in the reign of Landgrave Friedrich III, in 1765.

Conclusion

In Hood's dialogue the Master concludes with advice to his pupil that he should acquaint himself thoroughly with his globes: "It wil be unto you a great disgrace, especially in this our travelling age, not to be cunning in these things: which cunning you may easily attaine unto, if you doe but furnish your studie with the Globes, and now and then as your leisure serveth, looke upon them."

[1] Markham, in Hues, xxxii.

[2] *Twelfth-Night*, III, ii, 87–8. See C. H. Coote, in *Transactions* (1878) 88–89, and 'Note on the "New Map" ' in 'The voyages and works of John Davis' (Hakluyt Society, 1880), lxxxiv–xcv.

[3] It was published occasionally in Volume 2 (1599) and generally in Volume 3 (1600) of Hakluyt's 'Principal Navigations.'

[4] *Twelfth-Night*, III, ii, 29–31. See C. H. Coote, in *Transactions* (1878), 99, and 'The voyages and works of John Davis' (1880), xciii.

[5] Helena Normanton, "*Twelfth Night* at the Middle Temple," in *The Times*, 3 February 1951.

[6] 'Epistulae Ortelianae' (edited Hessels, 1887), No. 231.

This is a fitting conclusion to an account of the globes suggesting, as it does in some measure, how well they were to serve a generation of Englishmen already awakened to a sense of England's maritime destiny and also, appropriately, to a sense of the practical and academic value of Geography.

I am particularly grateful to Lord Leconfield for his kind hospitality and cooperation, and to Mr. R. A. Skelton, Superintendent of the Map Room at the British Museum, for all the very generous help and encouragement he has given me in my work on this paper. I am indebted also to Miss M. E. Seaton (Fellow) and to Miss C. Clark, both of St. Hugh's College, Oxford. The two illustrations of the Middle Temple globe are from negatives made for Dr. A. M. Hind's 'Engraving in England in the sixteenth and seventeenth centuries' (C.U.P.), and are reproduced with his kind permission.

APPENDIX

The Calendars of the horizon circle

It was natural for Blundeville to suppose that John Dee was the author of the "true calendar" on the horizon circle. At the request of Queen Elizabeth, Dee had made a new calendar for England in 1583, a year after the Roman Catholic countries of Europe had adopted the Gregorian calendar. He set out his proposals for reform in two learned discourses [1] addressed to Lord Burghley. On the true calendar of the globe, as Hues [2] explains, "the Equinoctiall and Solsticiall points are restored to the places that they were in at the time of our Saviour Christ's nativity", and this also was the principle of Dee's reform. But whereas Dee proposed that eleven days should be dropped from the Julian calendar, the true calendar on the globe was thirteen days ahead of the Julian (not fifteen, as Hood asserted) and presupposed the omission of thirteen days. Molyneux's three calendars are in fact identical with 'A Triple Almanacke for 1591' by "I. D.", published probably in 1590. Nowhere is the author's full name given in this work, and it too has been attributed by some to John Dee. But it proves to be similar in many points of style and substance to 'An Almanacke and Prognostication' for 1589, by John Dade. The publishers of both almanacs were Watkins and Robertes (necessarily, since this firm from 1571 to 1599 had a monopoly of the printing of English almanacs), and in the almanac of 1589 Dade uses the initials I. D. at the end of his address to the reader. There can be little doubt that the "I. D." of the Triple Almanacke, and therefore of the globe, was John Dade.

Molyneux evidently transcribed the Triple Almanacke in its entirety on his horizon circle. He may not even have known that Dee had composed a new calendar, nor anything of its nature. Dee was a secretive man and his manuscripts had not been published; and the English Church had refused to adopt his proposals,[3] involving as they did a compromise with Roman Catholic countries.[4] There is no evidence that Molyneux was acquainted with Dee, though in 1592 Dee was still living at Mortlake. Albert Markham has asserted that Dee and Molyneux were well known to each other.[5] He had identified

[1] MS. Ashmole, 1789 (i) and 179 (vii).
[2] Hues (1889), p. 21.
[3] 'Dictionary of National Biography' under Dee, p. 274b.
[4] John Strype, 'Annals of the Reformation' (1709), vol. 2, p. 354–5.
[5] Albert Markham (editor), 'The voyages and works of John Davis' (1880), viii.

Molyneux with a Mr. Emery to whom Dee referred in his diary, but a closer study would have revealed Mr. Emery as a dishonest retainer of Dee's, William Emery by name. Further, even if Molyneux had known of Dee's reform, or had gained access to his manuscripts, he would still have had to compile the calendars for himself. Dee's treatises were in no sense almanacs. For the same reasons, it is doubtful if Dade had any knowledge of Dee's reform when he made his own "True Calendar." In his address to the reader he explains that "this last Lent", he was in the company of "dyvers, aswell Worshipfull as Learned: amongst whom, upon occasion of talke geven, grew sundry argumentes about the true keeping of Easter; and thereupon, as upon an adiunct and thing appendant thereto, about the reformyng of the Kalender." The discussion ended with a request from the company that Dade (who was no doubt held in some respect as the author of a recent almanac) should compose a third calendar according to the "due and ancient Periodes." The argument could have reached this conclusion without anyone present knowing of, or mentioning, Dee's reform.

One may regret perhaps that it is Dade's system and not Dee's that has been perpetuated on the globe, for Dade's almanac, like all others, is a commonplace and dull work, save for the original feature of the "True Calendar". Dee's treatises are works of genius. Yet Dade's conclusion was accurate and Dee's was not, for though Dee's calculations were detailed and exact, the figure which he accepted for the place of the sun at the "Moment Radical" in the year of Christ's birth was two degrees in error.

SOIL EROSION AND POPULATION PROBLEMS IN SOUTH-EAST NIGERIA

A. T. GROVE

IN THE African colonies future development depends largely on full use being made of the soil and standards of living can rise only with increased production. This in itself entails the danger of soil exhaustion, of which accelerated erosion is often only a symptom. On account of growing populations and consequent overfarming, even the maintenance of present standards is already difficult in some areas. There are large areas in Nigeria with more than 300 persons to the square mile (Fig. 1) and though such concentrations are exceeded in the Nile valley and near a few industrial centres, they are comparatively rare elsewhere in Africa. In Nigeria these communities are almost entirely agricultural and faced with the problem of maintaining the fertility of land which is farmed more or less annually. In the vicinities of Kano, Katsina and Sokoto in the Northern Provinces mixed farming is practised, while the Ibos of the populous belt extending from Onitsha to Ikot Ekpene in the Eastern Provinces are hoe-cultivators largely dependent on their valuable oil-palm gardens. On the margins of these areas and within them, heavy pressure on the less carefully farmed land has contributed to soil deterioration and erosion.

The position in northern Nigeria has already been discussed before this Society. In 1935 Professor Stebbing alleged that the destruction of forests was causing an encroachment of the Sahara and that advancing sands presented a direct threat to farmland.[1] But three years later Brynmor Jones showed that the threat was not as great as Stebbing had suggested though he recognized the potential danger of uncontrolled shifting cultivation.[2] In many parts of the country the Agricultural and Forestry Departments have been engaged for some years in overcoming the technical problems involved in conserving the soil and in the far more difficult task of persuading peasant farmers to adopt improved methods.[3] A good deal of attention has been directed to that part of the Eastern Provinces where the great density of population has magnified the importance of soil impoverishment and large-scale gullying.[4] In 1945 a Soil Conservation Centre was established at Agulu, in Awka Division; this scheme was wound up in 1950. Dr. B. A. Keen, then Chairman of the Oil Seeds Mission to West Africa, visited the district in 1946 and, suspecting that the great gullies there were mainly due to natural processes of erosion, suggested that a geographer and a geologist should jointly

[1] E. P. Stebbing, "The encroaching Sahara," *Geogr. J.* 85 (1935) 506–24.

[2] B. Jones, "Dessication and the West African Colonies," *Geogr. J.* 91 (1938) 401–23.

[3] *Ann. Rep., Ag. Dept. Nigeria*, (1946) p. 40; (1947) p. 45; (1948) p. 44.

[4] R. A. Sykes, "A history of the anti-erosion work at Udi," *Farm and Forest*, Ibadan, 1 (1940) 3.

study the effects of land utilization on the topographical changes taking place.[1]

I arrived in the Eastern Provinces as the geographer early in 1948; a geologist could not then be spared but I was attached to the Geological Survey Department and was able to consult geologists engaged at that time in resurveying the Enugu coalfield. In the course of my survey I could not entirely ignore a certain spirit of unrest in sections of this territory and it added to the difficulties inherent in an inquiry amongst people who, despite their numerous schools and a network of roads, are still largely illiterate and

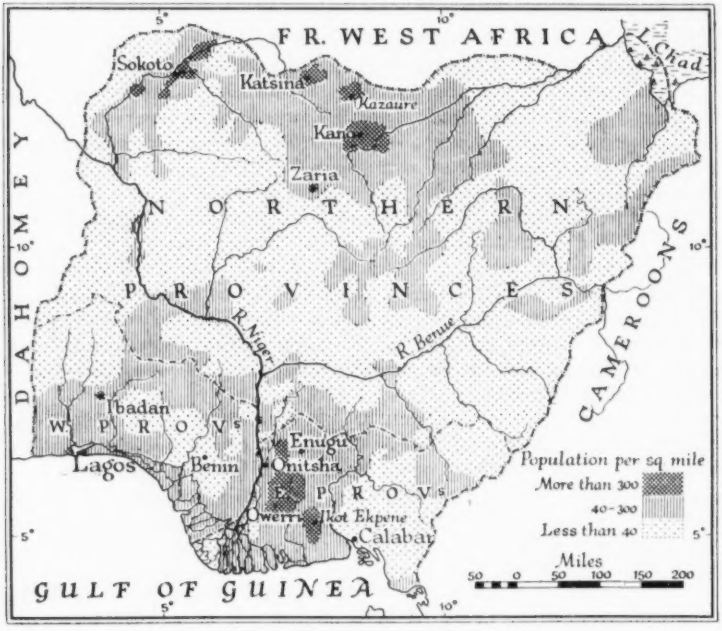


Fig. 1. Nigeria: population

with many fears. Like other peoples, both primitive and advanced, the Ibo are often averse to giving information concerning their families and their belongings. In particular they are extremely attached to their land and jealous of its ownership, so that they are highly suspicious of anyone who inquires into its use, and seeks to measure it. Groundless fears of losing their land can easily be fanned by irresponsible creators of discord, and this had always to be borne in mind. But such tendencies must not be exaggerated; for in most villages I found the people friendly and ready to give assistance. The advice

[1] See the summary of a discussion at the first Commonwealth Conference on Tropical and Subtropical Soils in 1948 in 'Commonwealth Bureau of Soil Science, Tech. Bull.,' no. 46. p. 231.

and hospitality given to me by Government Officers and by missionaries with special knowledge of their own localities was very valuable. I would also like to express my thanks to others who have assisted me in my work, especially the Royal Geographical Society, Professor Debenham, Dr. Raeburn, and Mr Steel.

Rainfall and vegetation

The area I studied (Fig. 2) includes most of the gullied hillsides of south-eastern Nigeria. Lying to the east of the Niger it forms a five-sided figure with an area of about 6000 square miles and comprises the whole of Onitsha Province and the northern part of Owerri. The southern margin runs parallel to the Gulf of Guinea and about 80 miles inland. It forms part of that transitional zone between the perpetually wet coastlands, the mangrove swamps and rain forests of the Niger delta, and the sparsely inhabited savanna land sometimes referred to as the "Middle Belt" of Nigeria.

The average annual rainfall decreases northwards; the town of Owerri receives about 95 inches and northern Nsukka about 65. In any one year there may be 20 inches more or less than the average, but there is almost invariably sufficient for the satisfactory growth of a wide range of crops, notably yams, cocoyams, maize and cassava, and this helps to explain the dense population. About 90 per cent. of the rain falls between early April and late October and, as 20 inches may fall in one month, the farmers are often more concerned to prevent the water-logging which may entail crop failure than to guard against the more insidious danger of erosion. The effects on the vegetation of the strongly marked dry season are intensified by the Harmattan, the dry north-easterly wind which is felt in most of the area during the dry season for spells of a few days at a time. Temperatures are high throughout the year, so that microbiological processes are active in the soil and organic matter tends to break down rapidly.

Such a climate may have supported rain forest or dry deciduous forest over a large part of the region, though little or no virgin forest remains and the character of the primeval vegetation presents a somewhat academic problem.[1] South-western Onitsha Province and most of Owerri are included in the main oil-palm belt extending from Benin to Calabar, while savanna woodland occupies large tracts of the Cross river plains, the Udi Plateau and the Anambra lowlands. Fresh-water swamp forest is still found along the larger rivers and rain forest fringes the smaller streams. On the uplands, forest trees are confined mainly to the villages, where they have been selectively preserved or, more rarely, planted. The oil-palm is the most numerous species and is of great importance, for on its produce depends almost the entirely cash economy of the Eastern Provinces. The other species in the village forests are almost all of value, providing bread-fruit, native pears, coconuts or timber. The edge of the forest is usually quite distinct so that, on the Udi Plateau for example, the villages form cool green islands set in poor grassland where fire resistant species of savanna trees become more numerous as the distance from the nearest village increases. The barren appearance of

[1] R. W. J. Keay, 'An outline of Nigerian vegetation,' Lagos, 1949.

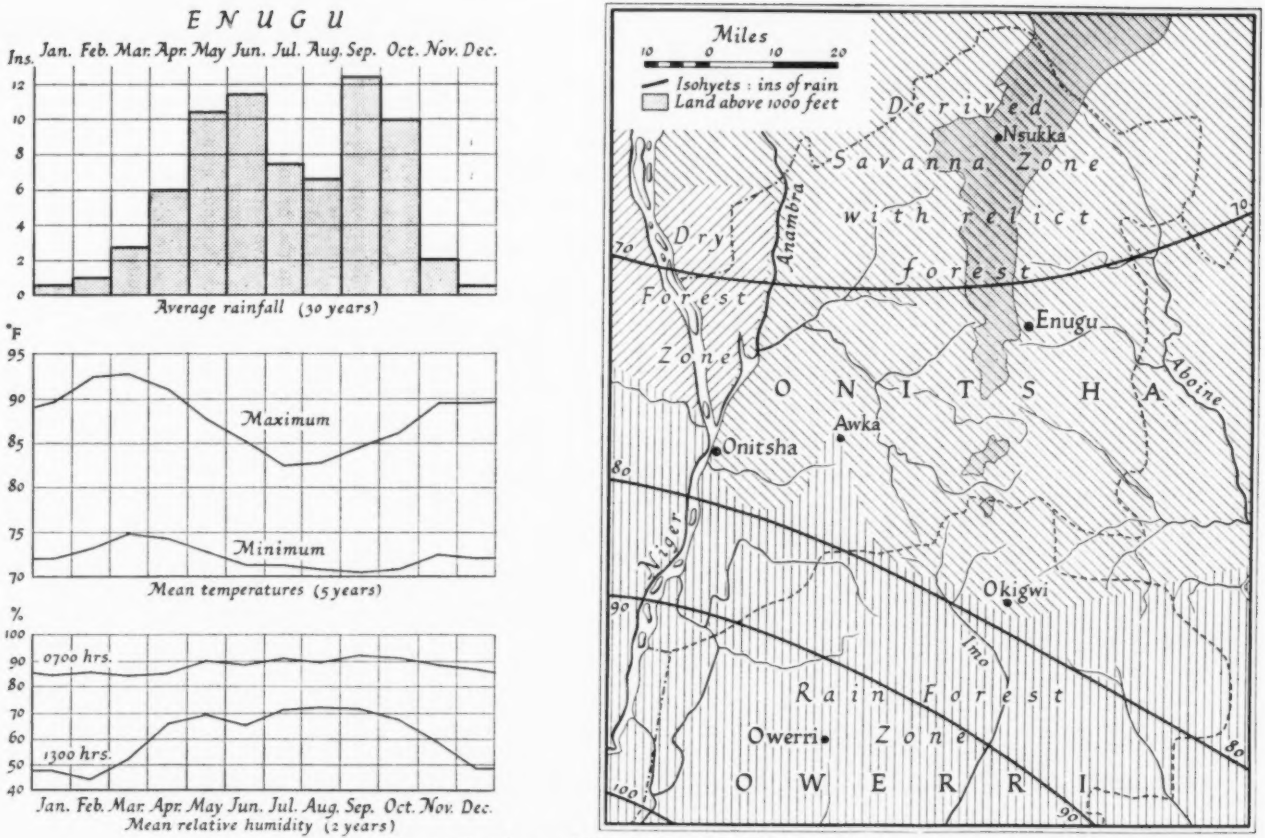


Fig. 2. South-east Nigeria: climate and vegetation

this outside farm-land is surprising in a region with such a high annual rainfall. The savanna vegetation is almost certainly a fire-climax; the grass is frequently subjected to annual burning and the trees are often felled or severely lopped. Despite such profound modifications, the general pattern of

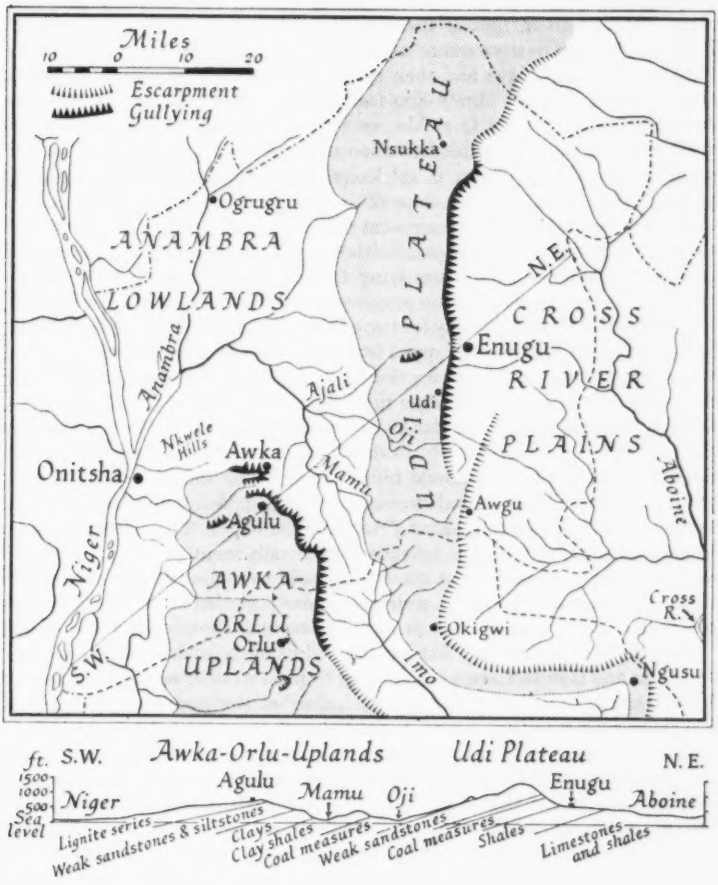


Fig. 3. Geology and structure

the vegetation can still be related to the soil and topography, either directly or from the distribution of settlements and land use.

Geology and soils

The best basis for regional differentiation within the area seems to be lithological (Fig. 3) and lithology largely determines susceptibility to erosion.

The sedimentary rocks which underlie most of Onitsha and Owerri are gently folded into an anticlinorium, pitching to the south-south-west, of which the eastern limb has been eroded away. Older more intensely folded Cretaceous shales, sandstones and limestones floor the Cross river plains, and younger Cretaceous rocks outcrop in the imposing scarp overlooking Enugu. This scarp, the eastern margin of the Udi plateau, extends from the Northern Provinces to the Oji river where it is overlapped by another escarpment continuing south to Okigwi and then east towards the Cross river. On either side of the road, which climbs 800 feet from Enugu to the Udi plateau, are coal mines in the Lower Coal Measures; higher up the hard sandstone and shales forming the bulk of this formation are succeeded by white, false-bedded sandstones, a thousand feet in thickness. For long distances these friable, porous rocks underlie the dip slope of the plateau and, north of the Oji river, they form the crest of the escarpment and have been deeply gullied. In the southern part of the escarpment, resistant Awgu sandstones form the scarp-face, and the softer sandstones lying farther behind it have hardly been affected. Younger rocks outcrop progressively towards the west. The isolated hills and ridges that rise steeply for two or three hundred feet above the general level of the Udi plateau are capped by Upper Coal Measures, and the sandstones and shales of this series floor the valleys of the Imo, Mamu and Anambra. Two low broken ridges run longitudinally across the riverain lowlands, and in the south-west the Awka-Orlu uplands form an indented scarp 500 or 600 feet high, fading out to the south in the coastal plain, and in the north-west amongst the Nkwele hills. False-bedded sandstones, again soft and gullied but of Eocene and later age, are interbedded with silts, clays and lignite and dip at angles of about 3° towards the Niger. The softer rocks are exposed only in ravines. The uplands are generally mantled by a great thickness of "red earth" sometimes 100 feet deep, but thinning out on the steeper slopes. These red clayey sands were at one time regarded as a separate formation, the Benin Sands, of Pliocene age. But sections exposing the base of the "red earth" indicate clearly that it is derived from the underlying sandstones and clays and is in fact a product of deep tropical weathering. Farther south, in Calabar where the rainfall is greater, similar "earths" assume an orange or a brownish-yellow colour. Throughout the southern part of the country they give rise to soils known as "acid sands." [1] Lateritic soils predominate on the argillaceous rocks of the lowlands and immediately above the grey soils of the alluvial flood plains they tend to have a pale surface horizon and a deep, brightly coloured, mottled sub-soil. Farther upslope, ironstone concretions occur in the soil at depths of a few inches. Cellular or pisolitic ironstone forms a flat capping to the outlier hills of Nsukka and Nkwelle and encrusts the surface along the western flank of the Udi plateau.

Soil erosion

From the topographical half-inch map it was evident that serious gullying is confined to the scarp slopes of the Udi plateau and Awka–Orlu uplands and the steep-sided upper valleys of a few dip-slope streams. This in itself

[1] H. Vine, "The soil resources for increased production," *Farm and Forest* 9 (1948) 21.

suggested that the gullies, if not natural features, are at least subject to strong physical controls. The Cross river plains and the Anambra–Imo lowlands are not affected, except by spreads of sand washed from the gullies and deposited by aggrading streams.

The gullies have formed in the "red earth" and have cut through it into the incoherent rocks beneath. They are of large size where long slopes include gradients exceeding about 15 per cent. and on more gentle slopes around deeply incised spring-heads; other factors affecting their occurrence were studied while mapping their distribution. An accurate survey would have required a great deal of time and rapid methods were employed, use being made of Forestry Department and other maps and a single strip of air photographs taken by the U.S.A.A.F. during the war. The main purpose was to obtain an approximate idea of the area affected, and in any event an aerial survey was expected in the near future. I estimated that about 25 square miles had either been occupied by gullies or so severely dissected as to be useless for agriculture. This is only one half per cent. of the region examined, but to assess the seriousness of this type of erosion one must estimate the rate at which the gullies are growing, and the value of the land being destroyed.

The accurate mapping of specimen gullies and frequent measurements of their growth have only recently been begun at Agulu. Some information could however be gained by observing the effects of individual storms and by studying the morphology of gullies varying in age. Under natural conditions surface run-off probably occurs but rarely on the sands; the water-table is frequently at a depth of 200 or 300 feet and the few rivers flow in deep valleys and are fed by seepage. At the upland margins numerous springs are thrown out of the permeable sandstones at their junction with less permeable underlying beds, and the springs tend to retreat headwards by sapping, caving and landslips. Deep canyons are therefore a natural feature of certain sections of the escarpments and at the heads of some dip-slope streams. Under a proper vegetative cover, their headward erosion is retarded by the binding effect of tree roots, by the dense growth about the spring-head itself and by the arrest of slipped material in the swamp-forest within. These entrenched spring-heads are usually deeply incised in gently sloping depressions where deforestation and farming have been followed by severe sheet erosion; the loose topsoil has been washed away to expose a less absorbent clayey subsoil. In addition, the storm water run-off from compounds, market-places and roads in the villages on the upper slopes is guided into the ravines by drains or by the sunken paths leading down to the springs. The whole process is accelerated by waterfall action at the rim, and by the storm water undercutting the steep sides and carrying away the debris which would have remained to buttress the walls.

Rarely is it possible to discover how long this accelerated erosion has been in progress. With an increasing density of settlement, interference with the plant cover may have reached a critical stage, so that prolonged rain or an unusually heavy storm was able to set the whole process in motion. The history of the Ibo people prior to this century is almost non-existent. Though slave-raids between 1650 and 1850 may have reduced their numbers, the introduction of new food crops such as maize and cassava must have improved their diet and reduced the toll of seasonal famines. More than five hundred

people live on each square mile over many parts of the uplands, and there are signs that the population is increasing. New requirements, of cloth, corrugated iron and bicycles, and taxes all throw a greater strain on the fertility of the soils than formerly. At the beginning of the century settled conditions made it possible to farm farther afield from the villages, yet fallow periods are now said to be shorter than ever before. Other factors such as the clearing of woodland and road-building also suggest that the erosion may be due to quite recent increases in run-off and may be the forerunner of more extensive dissection. Some roads have been cut by gully-heads in the past fifteen years and bridges over the Idi Mili have been swept away by high floods following the silting up of the river bed. The reality of man-induced erosion is also proved by the existence of gullies, formed in recent years on degraded soils, at a distance from the spring-heads. These compare with similar features mapped and studied in South Carolina.[1]

The slope gully originates as a narrow channel (often a footpath) at the foot of a convex slope, is enlarged by pot-holing, and lengthened by waterfall action at the head until it has attained a depth of a few feet. The undercutting of the sides then promotes earthfalls and slips, so that a rapid increase in the rate of erosion ensues while intense rain, often associated with "tornadoes" at the commencement of the rains, clears the fallen debris. The more continuous rain from June to September saturates the banks and induces the slumping of large blocks. Trees around the rim of the gully can offer little protection from this type of erosion and a cover can be established only with great difficulty on the raw sands and clays that are exposed, while the seepage of groundwater may prevent the construction of simple earth dams. Tributary gullies continue to develop until a wide area is dissected by a system of ravines, sharp ridges and isolated patches of grass or even forest. As a gully-head approaches the local water-parting its activity diminishes and the "red earth" around the head becomes dull with algal growths; ferns and mosses take root and trees spring up in the lower, damper reaches to form in time a dense forest. These stages of healing and stabilization are exhibited by some spring-head gullies in the Udi scarp, and crops of ground-nuts and cassava are now raised on the sandy terraces laid down by the streams at some earlier period of more active headward erosion. Many of the scarpfoot streams still meander over wide sandy beds and have formed sandbanks blocking the mouths of tributaries, to form swamps and lagoons. It appears that rapid erosion is mainly confined to a youthful stage in the development of a gully and if anti-erosion measures are to be effective they must be applied in good time. Later, the large structures required would be uneconomic, for the land which is still likely to be affected is often of low value.

Over the region as a whole there is evidence to show that gully encroachment during the past thirty years has not been sufficiently rapid to occasion very serious anxiety. Information from the local people, a large-scale map of the Enugu Colliery district [2] (surveyed in 1924) and photographs taken by

[1] H. A. Ireland, C. F. S. Sharpe and D. H. Eargle, "Principles of gully erosion in the Piedmont of South Carolina," *U.S. Dept. Agric. Tech. Bull.*, no. 633 (1939).

[2] A. D. N. Bain, "The Nigerian coalfield. Section 1, Enugu area," *Bull. Geol. Surv. Nigeria*, no. 6 (1924).

officers of the Geological Survey during the 1920's all confirm this.[1] Large gullies seem likely to be confined to the areas already affected, for steep sandy slopes only occur in certain valleys and at the upland margins; only locally is a shortage of land likely to be the result.

The survey of Oko

In parts of Awka Division clays interbedded with the deep crumbly sandstones have led to the formation of bottle-necked gullies of very great size and these are still active. To obtain a more complete picture of the situation, I

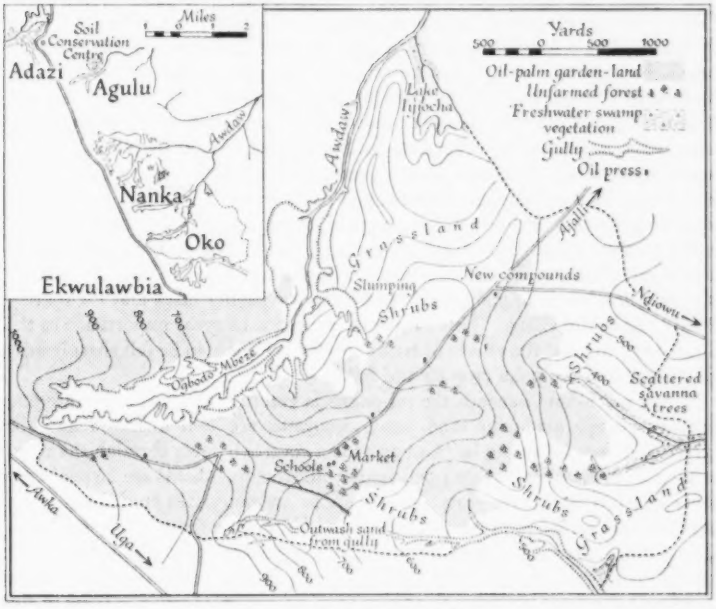


Fig. 4. The village of Oko

attempted to carry out a survey of a single village there. Soil impoverishment in the outside farm-land appeared to be a more serious problem than the spectacular ravines; such degradation usually precedes gullying and it was hoped that some quantitative data might be obtained.

The first village I approached made it quite clear that it did not wish to be surveyed, but eventually I made contact with some of the leading people in the nearby village of Oko (Fig. 4) which occupies a spur of the Awka escarpment between the gullied slopes of Nanka and Ekwulawbia. The whole area of about 5½ square miles was surveyed, using such rapid methods as compass traversing with a wheel or by pacing, and a map on a scale of six inches to

[1] R. C. Wilson and A. D. N. Bain, "The Nigerian coalfield. Section 2, Parts of Onitsha and Owerri provinces," *Bull. Geol. Surv. Nigeria*, no. 12 (1938).

one mile was produced. About 1400 acres on the crest of the spur are occupied by oil-palm forest; the "town" as it is called, where the majority of the 3000 inhabitants live in compounds scattered at intervals of about 100 or 200 yards amongst the trees and gardens. Large gullies form its boundaries on the north and south and open fields extend in a fan over the lower slopes to the east.

The village, or more correctly the village-group, of Oko can be considered for many purposes as an autonomous political unit. In the outer fields its boundary is ill-defined, for there is a zone where the plots of land claimed by small land-holding groups in Oko and the adjoining villages are intermingled. This situation often leads to disputes and it would be difficult to allot responsibility to villages for the manner in which the land in this zone is used or misused. Nearer the town, boundaries are more clearly defined, and in the individually owned household gardens they are fairly easy to determine. A family of about five lives in two or three huts surrounded by a high mud wall and farms about 2 acres of land in the town, most of it in the vicinity of the compound, where yams, cocoyams, maize and vegetables are grown almost every year in the shade of oil-palms and other trees. The trees and land are owned separately and one man may claim about twenty oil-palms; seven or eight provide wine and oil for the household, the fruit of the remainder and all the kernels being sold to local traders. The produce helps to provide cash for the purchase of trade-goods and foodstuffs, for paying taxes and for renting land outside the village. This source of income is of great importance in the local economy and the effects of land shortage are likely to be felt sharply only if the value of the palm crop should fall.

The garden-land beneath the oil-palms is carefully tended; leaves are dug into the heaps made for food-yams, cocoyams are well manured and the practice of intercropping helps to provide a good soil cover through the rainy season. This land can be cropped yearly, but the open fields are farmed only once in from four to six years; some sections are not worth cultivating at all, so that the average family farms less than half an acre there in any one year. Beans and cassava are grown but the chief crop is the small yam used as seed in the compound-land or on the moister soils the following year. *Acioa barteri*, a shrub which helps to restore fertility, covers about one-third of the open fields but does not reduce the fallow period required between cropping.[1] Perhaps land could be farmed more frequently if *Acioa* were to be established as a permanent cover on steep eroding slopes and its leaves composted for application to gently sloping land nearby.

Gullies occupy less than 6 per cent. of the entire village land and since their rate of enlargement is slow they affect the availability of farm-land but little. The loss of household garden-land and trees is sorely felt by less than a dozen families who live near the heads of gullies tributary to the Ogbodo Mbeze, where further recession could be retarded by diverting storm-water from drains and footpaths by simple measures on the surrounding slopes. In the open fields a larger area is affected, but it is not of great value and alternative plots of land can usually be obtained. The chief problem is simply that there

[1] A. T. Grove, "Farming systems and soil erosion on sandy soils in south-eastern Nigeria," *Bull. Agric. du Congo Belge*, 40 (1949), 2050.

is less than one acre of usable farm-land per head, of which more than half an acre is at a very low level of productivity.

This marginal land of the outside fields can be improved, though the necessary steps may not be economic. The Agricultural Department has, among other things, introduced artificial fertilizers and lime, at present distributed freely to those who are willing to try them. The suspicion with which some view the strange powders will no doubt be dispelled when their beneficial effects are realized. Nitrogenous fertilizers and lime have been found to increase yields by more than 20 per cent., but it is by no means certain that farmers can afford to pay for them.[1] The land is already well manured in many household gardens and the village domestic animals number over 3000. Goats remain near the houses, but cattle and sheep overgraze the open fields by day and the destruction they cause is an added incentive to lease farm-land in the less congested villages a few miles to the east. Gardens are protected from such depredation by temporary fences or low mud walls. The walls themselves may canalize run-off, but if carefully laid out they lead to the formation of contour platforms, where eroded soils slowly become more loamy. Their value has been appreciated in certain land-hungry villages such as Nanka, and their use might be further extended in the household gardens, but on the farm-land their construction might not be considered worth-while. The Ibo is quite capable of conserving the soil where natural conditions are favourable and the labour involved is adequately repaid; on steep slopes west of Awgu, stony soil overlying horizontally bedded sandstone is terraced and carefully farmed on the contour.

Perennial crops, notably the oil-palm, appear to be most suited to the light sandy soils of the uplands; they afford shade and protect the soil from heavy rain. A woody cover such as *Acioa* might easily be established and cashew trees, which produce a crop of potential economic value, seem to thrive. Oil-palms are more difficult to grow on account of their greater nutrient requirements. Oil-palm garden-land already occupies almost the entire area of villages where the population density exceeds 1000 to the square mile (as in parts of Orlu, Okigwi and Awka Divisions), while in less congested villages such as Oko the area under trees continues to expand. New compounds are built in the open fields after the ground has been manured and the trees planted; the soil is thereby much improved, and this trend seems one worth encouraging. As the new settlements extend along the roads linking the original villages, there is a tendency for the casual observer to over-estimate the total area under a tree cover.

Migration

The expansion of the palm gardens may be little more than the reflection o a natural increase in population, but such an increase is offset to some extent by migration from the uplands. About sixty of the younger men in Oko now plant yams in the lowland villages of Ofesi Odo, and many more from the Agulu and Abagana districts lease plots in the lower Mamu valley, or migrate seasonally as far as Ogwashi-Uku to the west of the Niger. There they may hire local labour to help clear the bush and they sell their surplus yams in

[1] *An. Rep. Ag. Dept. Nigeria* (*loc. cit.*).

Onitsha. The tax figures of Oko show a decline in the number of active males from 909, in 1939, to 734 ten years later. The emigration of the younger men to work at timber-felling in Benin may account for half of the decrease, others have become labourers, petty-traders, clerks or teachers in Onitsha town and in other parts of the Eastern Provinces. They maintain contact with their home-town through the local Progressive Union and exercise a considerable influence in village affairs. Emotional and religious ties remain, and many of the migrants intend to return to Oko later to build a house and raise a family. This temporary movement appears to be stimulated by the desire to earn a cash wage, by the local shortage of good farm-land and the small profit from farming. These desires no doubt contribute also to the enthusiasm for education apparent throughout the congested districts; in Oko more than 300 children attend school more or less regularly. The demand for youths with the literary standard they usually attain is however smaller than the supply, and there is a growing body of unemployed young men with a smattering of education who are unwilling to take up farming.

In this area the pressure on farm-land may be considered excessive where the average population density is greater than 300, or at most 400, to the square mile (Fig. 5). The numbers of active males given in the tax returns show that there are three main areas of congestion. The first extends along the crest of the Udi escarpment from Enugu Ezike to Obeleagu, the second lies to the south-east of Enugu and projects along the foot of the Awgu Escarpment, the third occupies the Awka-Orlu uplands and includes the village of Oko. A map does not adequately indicate the availability of land from place to place; this may be very different in adjacent villages and the position in Oko is representative of only a few of the villages. If a particular village had acquired territory as the result of fighting immediately before the establishment of British rule, forty years ago, it may now have an "outlet" to under-farmed land as a result.[1] Again, villages near the margins of the congested districts may claim land which has hitherto been farmed but rarely. In Figure 5 the arrows show recorded movements from one village or area to another. In Nsukka, the people of five villages in the neighbourhood of Ozala own only land with a poor sandy soil, and over the last ten or fifteen years increasing numbers have gone each year to farm in the Anambra valley or below the escarpment. They borrow land or lease plots for a single year. There are two dangers in this: they may be less welcome if they become too numerous and it is possible that they may farm in a wasteful manner with consequent soil deterioration. A few miles to the north-east, the large villages near Eha Alumona hold farm-land extending for some miles over the plains; as this fertile land is available, the poor upland soils nearer the villages tend to be neglected and gullies are regarded by the people as being of little consequence. The young men have for many years tended to settle permanently in the lowlands. Similar colonizing movements have long been in progress in parts of Udi; and the "colonies," which have become independent of their parent villages, now have little or no surplus land; the inhabitants of the older settlements must therefore travel to south-west Nsukka, Amadim-Olo, or to the Nike area north of Enugu in order to obtain land.

[1] L. T. Chubb, 'Ibo land tenure,' Zaria, 1948, p. 41.

The dependence of the upland villages on foodstuffs from the lowlands is reflected in the number and size of village markets throughout the region. In most villages a market is held once every four or eight days and may be attended by as many as 4000 people from within a radius of about 10 miles. Many women make a small profit from inter-market trading while some young men carry on a petty trade in imported goods such as cloth, cigarettes and

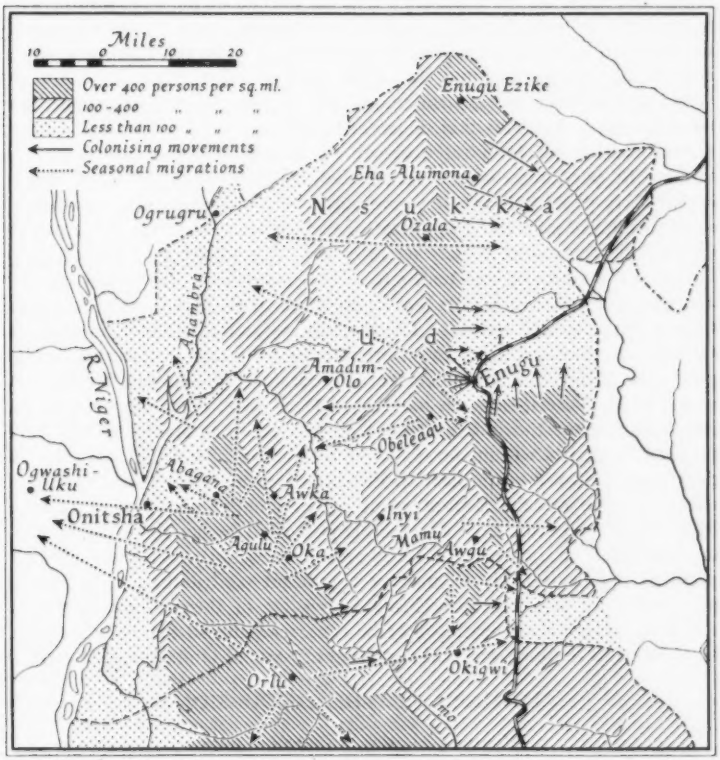


Fig. 5. Population density and migration

patent medicine. Most people are dependent on the produce of their own farms, though there is an increasing tendency towards specialization; in Oko for example there are ten carpenters. Some villages have a reputation in particular crafts; Awka for blacksmiths and Inyi, in Awgu Division, for pottery of a distinctive pattern which is traded over distances of about 30 miles; others are known for basketwork. With official encouragement, and improved transport there may be an opportunity for further specialization, based on aptitude and local raw materials. All such developments are still almost entirely financed by the sale of palm produce.

Large-scale industries lie in the future. The Enugu colliery helps to relieve under-employment in agriculture on the nearby Udi plateau, and the recently proved coal seams 50 miles farther north should benefit the people of Nsukka Division and Benue. New industries based on coal, on clay for brick-making, on limestone for cement and possibly on the lead-zinc ores of Abakaliki, are likely to be located in the vicinity of Enugu. Lignite deposits occur near the Niger and those on the right bank may be worked in the near future. The manufacture of sacks for palm-kernels is projected in Onitsha town. Prospecting for oil in northern Owerri has been intensified in the last two years and, if economic deposits are located, the region as a whole should benefit.

But such industries alone cannot solve the problem of too many people and too little food. The situation of under-cultivated land close to land that is worked-out has still to be rationalized. To be fully effective, any redistribution of the population would need to be on so large a scale that it would create more problems than it would solve. A more practical policy would seem to require a careful assessment of present trends and an endeavour to ease the readjustments already taking place. This might involve modifying the present systems of land tenure to relieve anomalies of land distribution,[1] and the promotion of village development schemes in the lowlands rather than in the congested uplands. The riverain lowlands of Ahoada, north-west Onitsha Province and the Cross river plains must in time become large-scale producers of rice, and Benin, Calabar and the vast "Middle Belt" hold great possibilities. Nevertheless, an increase in local trade, depending in part on improved transport, could stimulate food production in many small sparsely populated districts within the region here described. In effect, the relief of population pressure in the Eastern Provinces depends on efficient use being made of all the available natural resources throughout a wide area of Nigeria. More may be expected from the sparsely populated lowlands, for the restoration of fertility in the degraded sandy uplands presents an extremely difficult problem and is unlikely to make a significant contribution to increased production for some decades. More knowledge of these lowland areas is required, so that their fertility may be conserved and so that they may not be reduced to the impoverished condition of parts of Onitsha and Owerri.

SUMMARY OF THE DISCUSSION

Afternoon Meeting, 4 December 1950

Introducing the speaker, the CHAIRMAN (Mr. R. W. STEEL) said that Mr. Grove's appointment had arisen out of a suggestion made in 1946 by Dr. Keen, now Director of the East African Agriculture and Forestry Research Organization, that the problems of soil erosion in Nigeria called for study by a geographer, working with a geologist and perhaps a sociologist. This suggestion had been acted on by the Nigerian Government and the Colonial Office and, on the recommendation of this Society, Mr. Grove had been selected as the geographer for the task. His technical reports were to be published by the Nigerian Geological Survey.

Dr. C. RAEBURN (Formerly Director of the Nigerian Geological Survey) said that the Survey had been very glad to have Mr. Grove to work with them as a

[1] Lord Hailey, 'An African survey,' London, 1938, pp. 863–76.

geographer; it was a new development in the Colonies and there were still many tasks awaiting the attention of a geographer in Nigeria. Recent work in Nigeria, and particularly that done by Mr. Grove, had directed attention to the general problem of the progressive deterioration of soils and the need for conservation, whereas it had formerly been fixed on the existence of conspicuous gullies and on attempts at their repair. Mr. Grove had spoken of the "Middle Belt" of Nigeria but, because of the tsetse fly and scarcity of water, he did not think that it could yet be regarded as a field for Ibo colonization although it was only sparsely populated. He agreed that an improvement in agricultural methods offered the most promising solution, but there was the difficulty of persuading the people of the value of new ideas, and demonstrations confined to government agricultural stations did not always carry conviction. Nigeria was poor in natural fertilizers. The development of mining and industry would do something to reduce pressure on the land, and already the miners at the Enugu colliery, with their dependants, numbered about 40,000.

Dr. F. DIXEY (Director of Colonial Geological Surveys) congratulated the speaker on his use of coloured slides which illustrated the problems of erosion so clearly. The relatively high rainfall of the area described, from 60 to 90 inches, was in contrast to that of East and Central Africa where erosion problems arose with a rainfall of from 15 to 25 inches. In the more arid areas the long dry season perhaps provided a period of security from erosion, and assisted recovery. He was therefore interested to hear that these spectacular gullies did not present a very serious problem and that vegetation did re-establish itself within them. The photographs of the open grasslands, on the other hand, showed neither a recovery of vegetation nor yet any signs of gullying.

He thought that Mr. Grove's population figures of 300 to 400 per square mile were probably minima as he understood that figures as high as 1500 were not unknown; it was surprising that there was not more erosion.

Mr. G. B. MASEFIELD (Lecturer in Colonial Agriculture, Oxford) said that the area described was one of accelerated geological erosion rather than what one might call the "agricultural" erosion usually seen in Africa. It therefore lent itself to investigation by a geographer though he regretted that the full-time services of a geologist had not also been available. It was noticeable that, compared with East Africa, there was in West Africa a great lack of experienced agricultural soil conservationists. This lack should be met as well as looking at the broader geological and geographical aspects of the problem. The technique of sloping back the steep banks of gullies did not seem to have been applied. What he had himself heard at Agulu Enu did not tally with Mr. Grove's opinion that the great gully there was not extending catastrophically, for the Forest Guard had told him that he had jumped across it as a boy. Another characteristic of this area was the very low value of the land that was threatened; elsewhere it was usually the best land that was overworked and became subject to erosion. The real core of all these problems lay in land use and the selection of economically profitable crops that could be grown without danger to the land. Our present ignorance did not allow us to say whether field crops in such conditions would ever be safe.

Dr. R. J. HARRISON CHURCH (Lecturer in Geography, London School of Economics) said that he too had been to Agulu recently, and had visited the famous gully with the same Forest Guard; he got the impression that erosion was still in progress and that the administrative officers blamed it on native farming methods, which may have been unjust. He was surprised to hear that the Ibos practised terrace cultivation on their own initiative for he had not seen Africans do so elsewhere in West Africa.

Dr. G. I. JONES (Lecturer in Anthropology, Cambridge) said that this area did not seem to have been subject to slave raids in the sense that the Oriba country and parts of the Northern Province had been, and he agreed that this factor can scarcely have affected the growth of population which, even a hundred years ago, must have been dense. He said that this population, with a dense core of about 1000 to the square mile, was not primarily dependent on agriculture but on remittances of various sorts from its people who worked farther afield. In the densely populated area just south of where Mr. Grove was working there is none of the poor grassland left. All was garden and oil-palms, and the people were wealthier and better traders. It was difficult to persuade people to leave such congested and "distressed" areas for the backwoods where there are no amenities, and colonists might be more easily found from agricultural villages which produce the food that is traded to the "distressed" areas.

He was sure that the Ibos at Awgu had not been taught to make terraces by Europeans; these terraces were not on sandy and easily eroded soils but on good laterite and he believed that they practised a rotation, with the addition of household manure.

Professor L. D. STAMP said that he had visited Agulu about twelve years ago, when the vogue was for controlling the gullies by dams. This area was unique in many ways and he wondered if the streams showed signs of rejuvenation; that would be a different sort of soil erosion. He had also been impressed with the extent to which the vegetation re-established itself at the lower levels.

Mr. GROVE, replying to the discussion, said that there was some evidence of a rejuvenation of drainage in this part of Nigeria. But even in more advanced countries, with large-scale maps and a detailed knowledge of the geology, it was frequently difficult to ascertain what was happening to the rivers and he would hesitate to make any general observations on this subject. The results of rejuvenation, such as the steep slopes near to streams, could be recognized but he thought that the local base-levels of erosion could be considered stable over the period of time during which the gullies were formed. The larger gullies had developed from spring heads; accelerated erosion in such places might begin suddenly and continue sporadically until a wide area had been affected. At some stages enlargement might be very rapid, but individual descriptions by local people were not to be relied on. Some of these descriptions suggested that the larger gullies were neither of very recent nor yet of very great age; they might have developed over a period of perhaps 200 years, or possibly longer. If the small gullies were taken in hand, as they had been by the Forestry Department, they could be effectively kept under control by the construction of simple dams within and the planting of grass and trees.

On the sandy uplands the "red earth" contained little in the way of useful mineral salts and water soaked away rapidly during the rainy season. Even in the dry season however, soil at a depth of 5 feet or so remained moist and that was one reason why tree crops were well suited to these soils. Sheet erosion might occur but soil exhaustion, associated with lack of organic matter, was the main problem on the cleared uplands.

Population densities were at present uncertain and he had worked on the tax figures for active males, but they had to be multiplied by some indefinite factor. A census was now due and it would provide a better idea of the population densities. He had hesitated to deal with certain agricultural aspects of the problem; studies of the soils, and micro-biological studies especially, were required. He said that terracing was employed by the Africans on their own initiative at Awgu, and also on the Jos Plateau wherever there were areas of better soil which the people found it worth while to conserve.

ECONOMIC DEVELOPMENT IN ISRAEL

SIR CLARMONT SKRINE

SINCE DECEMBER 1946, when Dr. Willatts addressed the Society,[1] great changes have taken place in what used to be British-mandated Palestine. On 15 May 1948, in the midst of strife between Jew and Arab which rent the country asunder, the State of Israel came into being and during the year which followed, as a result of United Nations intervention, its frontiers were fixed *de facto* in successive armistice agreements with its four Arab neighbours. Of the 10,429 square miles which constituted Palestine, 7931 are now occupied by Israel, 2351 by the Hashemite Kingdom of the Jordan and 147 by Egypt. By far the longest of the "Armistice Lines," that between Israel and the Jordan Kingdom, is purely fortuitous and arbitrary; like the Indo-Pakistan border which bisects the Punjab, it represents no rational frontier, geographical or political. Yet, because it is a tightly-closed frontier, it has in three years achieved a measure of stability and the territories on each side of it must be treated as entirely separate units with self-contained economies. This paper represents a modest attempt by one whose acquaintance with the country dates but from May 1949 to give an account of present conditions and tendencies in the agricultural and industrial development of the State of Israel. Every effort has been made to deal objectively with economic and demographic facts and trends, but I have been obliged by the paucity of neutral sources to rely mainly on Jewish publications and I can only hope that the picture I present will not for that reason appear one-sided. Having spent—and happily spent—most of my thirty-six years of Eastern service among the Moslem peoples of India, Pakistan, Persia and Central Asia, I am confident that my friends in those countries will not impute to me any lack of sympathy with, or misunderstanding of, the Arab point of view.

For a succinct account of Palestine's physical characteristics, rainfall distribution and land classification, the student is referred to the early sections of Dr. Willatts' paper. He emphasizes the strategic position of the region at the meeting-place of three continents, on the margin between "the desert and the sown" *i.e.* nomadism and settled cultivation, and on the fringe of the world's second greatest oilfield; he remarks on the diversity of its physical characteristics and the contrasts, rare in so small a country, between richness and poverty in the soil of closely adjoining regions, and he stresses the uneven distribution of the rainfall, and its frequently unhelpful intensity which causes heavy erosion.[2]

Dr. Willatts' discussion of population trends was based on population and census statistics from the report of the Anglo-American Committee of Enquiry,

[1] E. C. Willatts, "Some geographical factors in the Palestine problem," *Geogr. J.* 108 (1946) 146–73.

[2] See map showing mean annual rainfall, *loc. cit.* p. 149. Only 43 per cent. of what used to be Palestine gets more than 12 inches a year, and 25 per cent. gets less than 4 inches. In most of the areas with under 12 inches there are usually less than 20 rain-days in the year.

1946.[1] From Figure 1 of this paper [2] it will be noted that under the Mandate, between the years 1922 and 1944, the total population of Palestine increased from 752,000 to 1,740,000. In 1944 the Jews accounted for 554,000 or 32·6 per cent. of the settled population, against 12·9 per cent. in 1922. Of this increase 338,180 or 74 per cent. was due to immigration; in the same period the Moslems, who formed the vast bulk of the non-Jew population, nearly doubled, but only 4 per cent. of their increase was due to immigration. After the large-scale migration of Arabs, during the 1948 hostilities, from the territory which afterwards became Israel, the number of Jews in the new State is estimated to have been 665,000; with 122,000 Moslems, Druses, Christians and other non-Jews. During the two and a half years which followed, no less than 514,653 Jewish immigrants arrived and the total population at the end of 1950, allowing for natural increase, was estimated as 1,370,000;

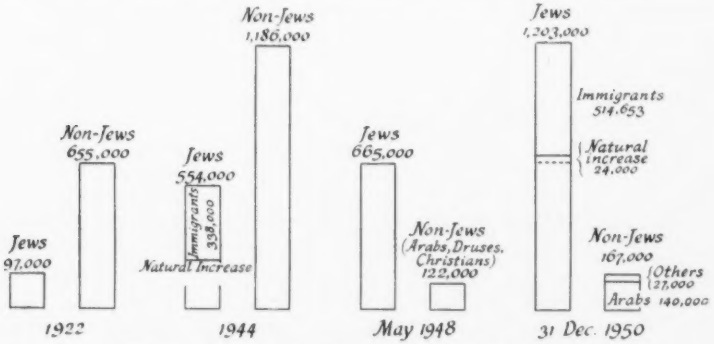


Fig. 1. The changing composition of the population

including 1,203,000 Jews, 140,000 Moslems, and 27,000 Christians and others. The density of population was then 172 per square mile for Israel compared with 167 per square mile for mandated Palestine. With immigration expected to continue at the present rate for at least three years and allowing for natural increase, it will be in the neighbourhood of 250 to the square mile at the end of 1953. The density will therefore be 50 per cent. greater in 1954 than it was for the whole of Palestine in 1946 when Dr. Willatts, supported by Mr. M. G. Ionides in the discussion which followed his paper, considered that "agricultural saturation" had been reached. Certain factors however operate in Israel's favour.

In the first place, Israel contains nearly all the best lands in what used to be Palestine. It will be seen from Figure 7,[3] where I show the present boundaries of the State superimposed upon Dr. Willatts' Land Classification Map,[4] that of the land area of Palestine (9157 square miles), 1214 square miles was "good" land of the first three classes and of this Israel now holds 1146 square

[1] Supplement to *Cmd.* 6808, map No. 5.
[2] The figures for 1948 are from Jewish official sources, and are only estimates.
[3] See folding sheet.
[4] *Geogr. J.* 108 (1946) 163.

Monastery of the Cross, Jerusalem. Jewish suburb of Rehavia in the background

In the Quarter of the Knights of St. John, near the Holy Sepulchre

Julian's Way in the New City, Jerusalem

miles or nearly 96 per cent. Egypt and the Kingdom of the Jordan between them, with 24 per cent. of the former Palestine, hold a little more than 4 per cent. of the best lands. A glance at Dr. Willatts' rainfall map [1] will also show that Israel holds considerably more than her proportionate share of the most copiously-watered regions.

In the second place, there has from the outset been a marked contrast between Moslem and Jewish agricultural standards and land tenure systems. In the Levant as elsewhere, Moslem agriculture is predominantly of the "extensive" type, primitive in equipment and technique and dependent almost entirely on timely rainfall.[2] It is suitable enough for a people with a comparatively low standard of living, kept relatively stable in numbers by recurring epidemics, famines and civil strife, but hopelessly inadequate to the needs of a settled population growing rapidly with improving hygiene. Between 1922 and 1944 the Arab population increased at the astonishing rate of 2·6 per cent. per annum and the resulting pressure on the land led to an extreme fragmentation of holdings, accompanied as usual by the evils of over-grazing, improvident methods of cultivation and ever-increasing soil-erosion. It was mainly these factors that brought about Dr. Willatts' "agricultural saturation" towards the end of the Mandate; Jewish immigration, and the sale by Arabs to the Jewish National Fund of a quarter of a million acres of their best land, merely aggravated an already-existing and very dangerous trend. The Jews, on the other hand, have long specialized in intensive cultivation and in the reclamation of marginal lands. The influx of vast sums from world Jewry for the development of both agriculture and industry has lavishly equipped Jewish agriculture with machinery, piped irrigation, sprinklers, fertilizers and other aids. The transformation of malarial swamps such as those of Hadera and Degania into rich wheat-lands, citrus orchards and groves of tall eucalyptus ranks among the finest achievements of modern agricultural reclamation. There is little open grazing on Jewish lands, and none worth speaking of by those scourges of agriculture, goats; every effort is made to reduce erosion and to conserve the topsoil. Last but not least, in place of the uneconomic land tenure system of the Arabs, Jewish farmers work in highly-organized communal and cooperative settlements. The parallel evolution of Jewish agricultural communities along collective and cooperative lines in recent decades is one of the most fascinating sociological studies in the world to-day. It would be far beyond the scope of this paper to attempt an essay on the comparative merits of the *kibbutz* or communal settlement, the *moshav ovdim* or cooperative village and the *moshav shitufi* which seems to be a compromise between the two [3]; but it may safely be said that the social

[1] *Geogr. J.* 108 (1946) 149.

[2] Citriculture is a notable exception to this generalization, for about half of the highly-capitalized and elaborately irrigated citrus groves of Israel were owned and worked by Arabs; see page 317.

[3] See Plates. The Zionist Information Office's weekly news digest for 6 June 1951 gives the following figures:

Cooperative Settlements (Moshav Ovdim)	215
Collective Settlements (Kibbutz or Kvutza)	211
Collective Smallholders' Settlements (Moshav Shitufi)	26
	452

organization of Jewish farmers combined with their intensive techniques and ample capital equipment, and the relative superiority of their soil, enable them to make considerably better use of their natural resources than was achieved, on the whole, by Moslem cultivators in the days of the Mandate.

But these factors alone would not ensure self-sufficiency in foodstuffs and a balanced economy. The political and economic handicaps to agriculture as well as to commerce and industry may well seem at times quite overwhelming. That these burdens are self-imposed does not make them any easier to bear; Israel has only herself to thank if the flood of immigration gets out of control at times, while the Arab boycott is but part of the liability which she deliberately incurred when she defied and defeated the armies of neighbouring Moslem states. In these circumstances it is indeed fortunate for Israel's farmers that they have the guidance and support not only of their elected Government and the Histadruth (General Confederation of Labour) but of the powerful Jewish Agency which administers the great National Funds, Keren Kayemeth and Keren Hayesod, through which the generosity of World Jewry pours its riches into struggling Zion. In the paragraphs which follow an attempt has been made to indicate the main lines on which these authorities have guided and developed Israel's agriculture and industry since the creation of the State in May 1948, and to sketch such of their plans for future development as are of special geographical importance.

Basic problems of irrigation and water supply

Of all Israel's plans, those for irrigation are perhaps of the greatest geographical interest. The ambitious "Jordan Valley Authority" scheme first propounded by Dr. W. C. Lowdermilk in 1944 in his book 'Palestine, land of promise,' and elaborated by Messrs. J. B. Hayes (formerly Project Manager of the Tennessee Valley Authority) and J. L. Savage (designer of the Grand Coulee and Boulder dams in Colorado) is well known. It envisages the following steps:

1. Damming the Hasbani (Jordan) and Litani Rivers in Lebanese territory and carrying their waters by a high-level canal to a large reservoir to be constructed in the Sahl-el-Battuf basin of Central Galilee.
2. Irrigating lands in Galilee, Esdraelon, the coastal plains and the Beisan district with water from (1) and from minor streams, wells and flood-water dams in Israel territory.
3. Diverting the Yarmuk, a left-bank tributary of the Jordan which forms the boundary between Syria and the Jordan Kingdom, into Lake Tiberias in order to keep up its fresh-water level.
4. Bringing Mediterranean water by canal and tunnel into the 1300-foot trough of the lower Jordan (*a*) to keep up the level of the Dead Sea, (*b*) to generate 660 million kilowatt-hours of electricity annually.
5. Carrying surplus water from (1) by a hundred-mile-long canal southwards along the western foot of the hills to the Egyptian border, for the irrigation of the coastal plain and the northern fringe of the Negev.

The Israel Government and the Jewish Agency are well aware of the impracticability of this grandiose scheme. The criticisms in Dr. Willatts' paper

already quoted apply with even greater force now than they did in 1946. There is even less hope for Israel than there was for British-mandated Palestine of securing the satisfactory cooperation of Syria, the Lebanon, and the Kingdom of the Jordan.[1] The cost of labour and equipment, then estimated at £50 million, would at existing rates in Israel be at least I£250 million, equivalent to I£400 per acre or many times as much as any other irrigation project in the world.[2] Again, the technical difficulties might easily bring the whole scheme to nothing; as Dr. Willatts points out, the amount of water to be diverted and stored (2,200,000 cubic metres) is more than the whole normal discharge of Palestine's streams and rivers. The difference is to be made up by the storage of winter flood water; but anyone who, like myself, has experience of flood-storage works in similar lands further east will agree with Dr. Willatts that losses by evaporation, by seepage through porous rocks, and from damage to canals by uncontrollable floods would reduce the amount available from this source to negligible proportions.

For these reasons the Israeli planners are concentrating on shorter-term schemes, based on the Hayes-Savage report and more recent expert opinion, which are definitely practicable. These are grouped regionally and depend on sources entirely situated in Israel territory; on rivers such as the Yarkon near Tel Aviv; on springs; on deep-well borings; and on flood-water conservation where conditions are technically favourable. An admirably lucid description is contained in an article by Mr. P. H. Doron, of the Jewish Agency's Irrigation Office.[3] His map, reproduced by courtesy of the Jewish Agency, shows the various systems already in operation, under construction, or proposed. The most ambitious is the Yarkon River scheme; it envisages two interconnected concrete pipelines, an eastern and a western, both running towards the Negev, receiving additional water on the way from wells in the coastal region and reinforcing when necessary the district systems (E, F, G, and H in Fig. 9).[4]

One of the later stages of the Hayes-Savage scheme is the Lake Hula project which figured so prominently in the news early this year. Lake Hula and the swamps to the north (Fig. 2) lie 6 feet above ocean level, in a basin formed by the banking-up of the waters of the Jordan by deposits of marl and clay. Through these latter the river cuts its way in a channel too narrow to carry all its silt away. The first stage of the work, in the words of a recent authoritative article on the subject,[5] is "to enlarge the river-bed of the Jordan for a 4½-kilometre stretch south of Lake Hula. This, it is estimated, will increase the flow of water from the present 20 cubic metres per second to more than 80—enough to handle the annual floods." In the second stage "the course of the Jordan and its tributaries north of the Lake will be diverted into artificial channels following the lowest contours of the land, and finally, through a network of drainage canals, the stagnating waters will be drawn off."

[1] See an article on the Jordan project by M. G. Ionides in *The Times*, 2 August 1951.

[2] According to Dr. Willatts, the capital cost of irrigation in the Punjab and Egypt works out at £2 per acre, and that of the Godavari scheme in S. India at under £14 per acre.

[3] *Israel and the Middle East*, June–July 1950, pp. 93–6.

[4] See folding sheet.

[5] *Karmeni* (published by the Jewish National Fund), January 1951, pp. 3, 4.

It is estimated that the work will take five years and cost I£ 4,000,000. On the total area to be reclaimed it will be possible to establish 2000 new farms with a large output of grain, groundnuts, vegetables, fruit, livestock, and fish.

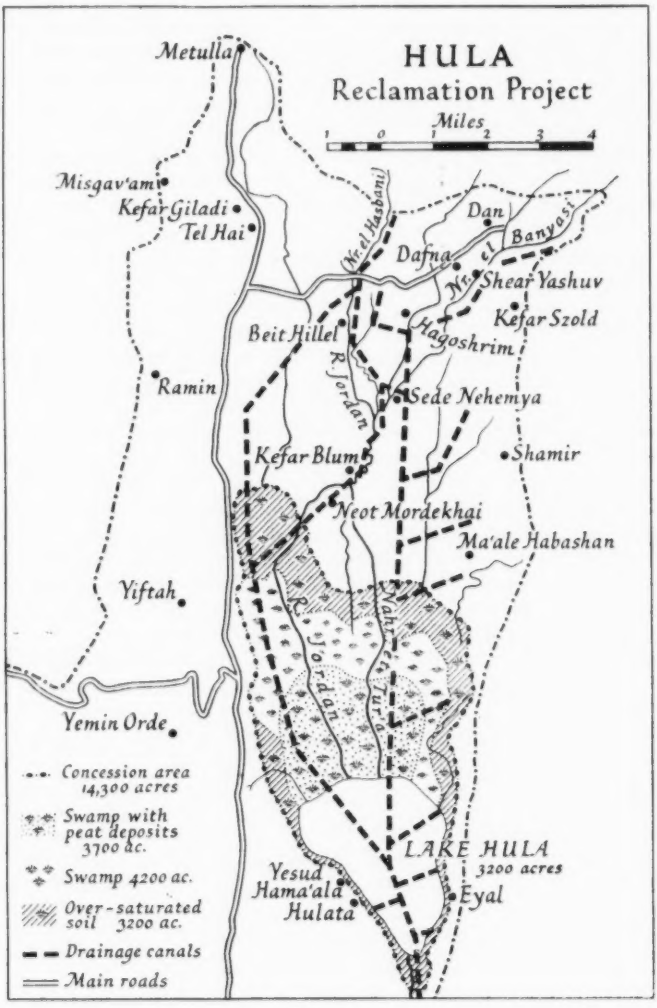


Figure 2

Further, the quantity of water annually saved from evaporation will be sufficient to bring another 50,000 acres of the Jordan Valley under cultivation. The under-water deposits of a kind of peat which cover approximately 3250

acres will add notably to Israel's fuel supplies. Last but not least malaria, for which the district is notorious will be eradicated by the draining of the swamps. So technically feasible is this scheme, and so attractive on its own merits, that the new concessionaires, the Palestine Land Development Co., began the work of cutting drainage channels south of the lake about the middle of last March. Unfortunately, the area concerned happened to lie in a demilitarized frontier zone between Israel and Syria, and certain Syrian Arab farmers had to be evicted. So began a long series of "incidents" of varying seriousness between Jewish troops, police, and labourers on one side and Syrian troops and farmers on the other. The Syrians complained repeatedly, both to the local Mixed Armistice Commission and to the Security Council of the United Nations, against what they described as Israel's violation of the Armistice Agreement in proceeding with the scheme without the sanction of the Armistice Commission. They had from the outset been dissatisfied with the international boundary, drawn by the Powers after the 1914–18 war, which gave Palestine certain territorial and riparian rights which Syria claimed. They also objected that the scheme would radically alter the strategic situation on that sector of the frontier by making the terrain suitable for tanks. The Israelis argued that the work they were doing was of a purely civil nature, without military implications and beneficial to the inhabitants on both sides of the border; as for the evicted farmers, they would be compensated fully with money or equivalent land elsewhere in the area.

On 8 May 1951 a Security Council resolution called upon the parties to cease hostilities and respect the undertakings they had given in the original armistice agreement, and another on May 18 forbade Israel to proceed further with any part of the Hula scheme until the dispute was finally settled. These injunctions by themselves had little effect but, meanwhile, negotiations on the Mixed Armistice Commission at Jerusalem under the soothing influence of its able Chairman, Major-General Riley of the U.S. Army, resulted in a cessation of the regrettable frontier incidents. At the time of writing (July 1951) an uneasy peace prevails and work on the Reclamation Scheme continues; but the dispute is no nearer settlement than before. Apart from the military implications of the project, which if carried out would remove a useful strategic barrier along 7 miles of the frontier, it is not to be expected that Syria will acquiesce indefinitely in the exercise by Israel of riparian rights in this sector of the Jordan valley. Yet the Hula scheme is admirable both economically and hygienically; moreover, unlike the Jordan Valley project as a whole, its soundness as a commercial proposition is beyond doubt. If even such an undertaking cannot for purely political reasons be carried out, what hope is there for other plans which benefit Israel primarily, but depend on the cooperation of neighbouring Arab States?

One of the chief forms of assistance given to the new settlements in Israel is piped water. This is done through "Mekoroth," [1] a corporation founded during the Mandate by the Histadruth with capital lent by the Jewish Agency. The volume of water supplied by Mekoroth has risen since May 1948 from 20 million to 45 million cubic metres a year, a measure of the progress of Israel's settlement both urban and rural. Mobile drills, one of them a

[1] For Mekoroth's contribution to the Irrigation Plan, see footnote 4 at page 322.

"Hopper" which can pierce to a depth of 2000 feet, have been imported from America with the help of allocations from the hundred-million-dollar loan granted to Israel by the Export-Import Bank. With these, large underground water reserves have been tapped in the hills of Ephraim and at Kefar Uriya in the Judean foothills; this latter will soon increase Jerusalem's water-supply by 50 per cent.[1] The importance of this service to the colonization of the Negev, that arid southern region which comprises no less than four-sevenths of Israel's total area, cannot be over-emphasized (Fig. 3). At the time of writing there are at least 51 settlements in the Negev, and more being started almost every week; in 1948 there were only 26. Beersheba with a population of 8000 and Eilat, Israel's port on the Red Sea next door to Akaba, have been elevated to the rank of municipalities. One of the most hopeful features in Israel to-day is the glamour that the deserts of the Negev evidently have for her youth; quite a number of young men and girls, many of them from well-to-do families, are enthusiastically pioneering there.

Land and labour

One of the first actions of the new Government of Israel in May 1948 was to repeal the Mandatory Government's law restricting the sale of agricultural land by Arabs to Jews. This enabled the Jewish Agency, which already held 237,000 acres, to resume the purchase of land from private owners in all parts of the country. In January 1951 the Agency owned more than half a million acres, and another quarter of a million were in process of transfer. Practically all these new acquisitions represented sales of Arab lands by the official Custodian of Abandoned Property on behalf of their refugee owners, the Development Authority Act passed by the Knesset (Parliament) last autumn empowering him to do so. Of the 537 agricultural villages of all kinds and sizes in Israel at the end of last year, 470 were on Jewish National Fund land, and another 251 are planned. The justification, from the Israeli point of view, of these huge acquisitions is of course the overriding necessity to absorb immigrants by the hundred thousand. Some idea of the difficulties involved in settling a sufficiently large proportion of the incoming hosts on the land, where they are most urgently needed,will be obtained from Table 3 (Appendix) for, of more than half a million immigrants, less than 1 per cent. can be classed as farmers, foresters or fishermen. It is not surprising that during 1949 and most of 1950 the floating population of the "reception camps" was seldom less than 90,000. The delay in finding work for an immigrant is not only bad for him, but represents an appreciable loss of potential man-power to the country.

In these circumstances the development, during 1950, of *ma'abarot* (transitional settlement camps) is of interest. They are described[2] as "a type of settlement comparable to labour camps based on employment in near-by communal settlements, citrus plantation, land development, and afforestation projects, as well as public works schemes" and vary from 100 to 1000 families, living in huts, tents, deserted Arab houses and any other accommodation available. The inhabitants are no longer dependent on charity as in the

[1] *Karnenu*, January 1951, p. 12.
[2] *Israel Economist*, March 1951, p. 56.

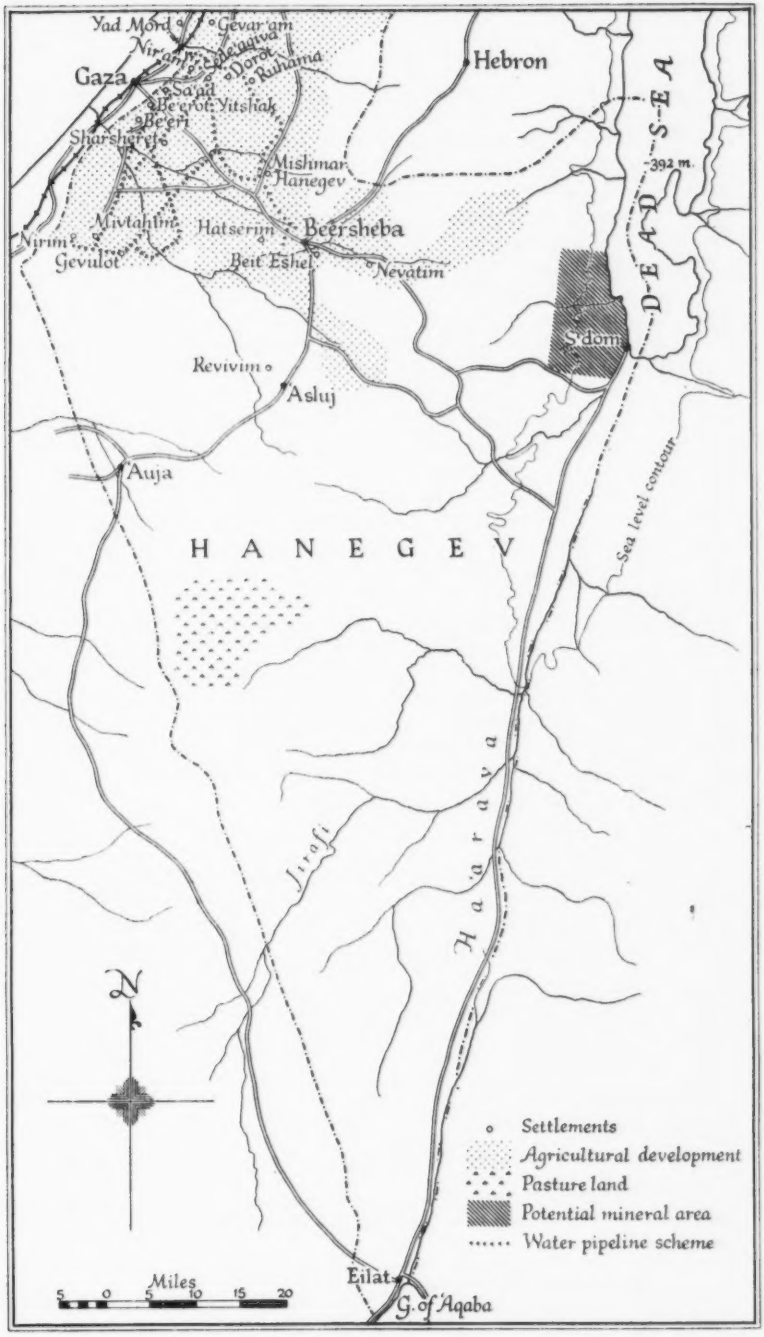

Yad Mord
Gevar'am
Nir'am
Dorot
Ruhama
Gaza
Sa'ad
Be'eri
Yitsiak
Shuvheryt
Hebron
DEAD SEA
392 m.
Mishmar Hanegev
Mivtahim
Hatserim
Beersheba
Nirim
Gevulot
Beit Eshel
Nevatim
Sdom
Revivim
Asluj
Auja
HANEGEV
Sea level contour
Hatsevah
Hatsevah
Settlements
Agricultural development
Pasture land
Potential mineral area
Water pipeline scheme
N
Miles
5 0 5 10 15 20
Eilat
G. of Aqaba

Figure 3

"reception camps," the population of which had by March last sunk to 41,247, but earn their own living. It is planned to develop the *ma'abarot* into independent agricultural settlements or new suburban areas according to their location. In the Jerusalem Corridor for example there are 28 of them, called *kafrei avoda* (work villages), for the special purpose of colonizing and defending this strategically important but under-populated zone. It has been found that from 80 to 120 man-days of work are required to clear each acre of rocky soil in the hills; in the winter when conditions are unfavourable for this work the villagers are employed on afforestation.[1]

Immigrants placed on the land, whether in the older settlements or in new ones, receive substantial assistance from the Jewish Agency, the Histadruth, and the Israel Government. Newcomers to farming are trained, and maintained *ad interim*; tools, seeds, fertilizers, tractors, trucks, irrigation equipment, etc., are supplied on credit, and mobile well-boring plant is loaned to villages seeking water. As a result the production of wheat and rye rose to 44,000 tons in 1950–51 as against 15,000 tons in 1947–48 and now represents 25 per cent. of Israel's total consumption, although the main emphasis is nowadays on the production of fodder. By the end of this year 750,000 acres of land will be under cultivation, compared with 597,000 last year and 412,000 in 1948–49. Unirrigated field-crops account for the larger part of the increase (84 per cent.). Two thirds of the area cultivated last year, 314,000 acres, were farmed by Jews and the rest by Arabs. The Arabs, who include the Moslem remnant that stood its ground at Nazareth, Abu Ghosh, Jaffa and elsewhere in the fateful days of 1948, now number 127,896 living in 102 villages. To judge from the reduction by 15,000 acres in the Arab-farmed area under cereals in 1949–50, compared with the previous year, and from an increase in the cultivation of vegetables, tobacco and pulses, Arab farmers show a hopeful tendency to switch over from extensive to intensive cultivation.

The outlook for agriculture

By far the most important of Israel's agricultural products, from the point of view of earning foreign currency, is citrus. In the 1938–39 season Palestine exported 15,310,437 cases of oranges, grape-fruit, and lemons[2]; a quantity which at 1949–50 prices would have fetched I£24 million.[3] By 1949 however

[1] There is no question that the *ma'abarot* idea is a good one. But propaganda statements to the effect that the immigrants in them have been "absorbed into Israel's rural economy" must be treated with reserve. Many of them work in towns and factories, not in rural districts; a large proportion of them work only three days or less in the week, either because there is not enough work to go round, or because employers regard them as not up to standard, or (in most cases) because they have no desire for full-time employment. Table 2 shows that only 2·5 per cent. came from the high-standard countries of Western Europe and America; for an immigrant family from Iraq, the Yemen, or Cyrenaica, the standard Histadruth wages the breadwinner receives for three days' work in the week are quite enough. They cannot therefore be classed as "fully employed" and it is only by ignoring the part-employment of the population of the *ma'abarot* that socialist Israel can boast that, like Britain, she has "full employment."

[2] *Israel Economist*, January 1951, p. 16.

[3] *Israel Export Journal*, May 1950.

The coast near Herzlia under snow, 4 February 1950. Fortified village and mosque of Sidna Ali on right

Near the Mandelbaum Gate, Jews watching an Arab sentry

Orthodox Bokharan Jews in the Mea Shearim Quarter

the entire body of Arab growers, representing about half the industry, had disappeared with the refugees leaving their groves untended; meanwhile, owing to the loss of markets during the Second World War, the area under Jewish cultivation had dwindled from 37,500 acres in 1939 to 22,500. The enormous rise in the cost of labour further handicapped the industry and only 4,221,810 cases of citrus fruits were exported during the 1949–50 season. Even so, these exports brought in £6,250,000 or 47·4 per cent. of Israel's total exports for 1950. It was hoped that the figure for 1950–51 would reach 6 million cases but only 4,185,112 were exported, chiefly to Britain. In addition however, 140,000 tons (equivalent to 3,500,000 cases) were sold on the home market, against 75,000 tons in 1949–50.

Now that the British Government no longer buys the crop in bulk, high labour costs make it almost impossible, without Government assistance, for growers to compete on the European market with South Africa and other rivals. Under last season's agreement, export premiums were paid by the Israel Government at the rate of 15 per cent. on the growers' net earnings of foreign currency. In addition, the Government indemnified growers against loss up to the amount of 8 shillings per case of *shamouti* oranges and 4 shillings per case of grape-fruit, based on the previous year's prices of 33 shillings per case of shamouti and 29 shillings per case of grape-fruit.

Citrus-growing for export cannot therefore be said to be economic in present conditions; but, again, heavy capital expenditure from overseas sources may one day redress the balance. With the help of I£6,500,000 in loans (mostly out of the Export-Import Bank's hundred-million-dollar credit) growers were able to import a large quantity of the latest equipment for sprinkler-irrigation from California in 1950.[1] Seventy-five per cent. of the groves are now thus equipped and it is estimated that costs will be reduced by 25 to 30 per cent. and yields doubled within three years. That Israel's citrus growers have faith in the future is shown by the floating of "Mehadrim," with a capital of I£1,000,000, by a group of leading growers who have leased 5500 acres of land from the Jewish National Fund; they have taken up $625,000 from the Export-Import Bank loan and are installing sprinklers. It is interesting, but sad, to note that these men evidently believe it to be more profitable to plant new groves than to rehabilitate abandoned ones.[2]

Before turning to industry, a note on afforestation plans may be of interest. The State inherited a flourishing Forestry Department from the Mandatory Government with 120,875 acres of land under its jurisdiction[3]; the Israelis are tree-lovers and the work of the Department is being pursued with

[1] The sprinkler system saves 25 per cent. of the water, thanks to more even distribution and less evaporation, and doubles productivity, permitting 2–2½ acres to be watered by one worker in a day compared with ¾–1 acre without sprinklers. Channels and basins being no longer required, small tractors can be used between the rows of trees for the cultivation of vegetables, lucerne, ground-nuts, etc.

[2] *Jewish Agency Digest*, Vol. III, No. 29, p. 1145.

[3]

Plantations	5,000 acres
Natural forest	12,500
Open forest reserves	102,000
Private forests under control	1,375

vigour. A million saplings raised in the department's nurseries were planted last year and 2·2 million were ready this spring for planting in the current season. Roughly one-third of these were conifers, one-third eucalyptus, and one-third other deciduous trees. Three new nurseries are being established at Nahariya, Kefar Yossef and Zipori, and the planting programme for 1951–52 is 8·8 million saplings. Much work is also being done for the orchards and the following figures show the expansion in this sphere:

	Season 1949–50	Season 1950–51
Deciduous fruit trees	30,000	230,000
Olives	25,000	40,000
Vine seedlings	200,000	800,000
Sub-tropical (bananas, etc.)	10,000	40,000
Citrus	30,000	500,000
Total ..	295,000	1,610,000

The expansion of industry

In Mandatory times the same contrasts that existed between Jewish and Arab agriculture marked the industrial organization of the two communities. Jewish industries were more highly capitalized than Arab and better equipped; Jewish wages were more than twice as high as Arab wages and the output per head was higher. Seventy-five per cent. of all industrial man-power was Jewish, and Jews predominated in foodstuffs and drinks, textiles and clothing, machine construction and chemicals. With the virtual disappearance of the Arab element this dichotomy does not exist; freed from the competition of cheap Arab labour, and enabled by its privileged status practically to dictate tariff policy, the Histadruth (General Confederation of Labour) dominates the scene.[1] But the problems which face industrial Israel are more difficult than ever. Before the Second World War 15 per cent. of Palestine's industry was concentrated on consumer goods and over 90 per cent. of production was for the home market.[2] "The war" Dr. Willatts says "brought opportunities for great expansion in many types of industry to satisfy the urgent demands of great armies perilously removed from their main bases of supply. Industry nearly trebled between 1939 and 1942." Expansion was aided by cheap oil brought by pipe-line from Iraq to Haifa and refined there, and also by the expanding output of the Palestine Electric Corporation's thermal plants at Haifa and Tel Aviv and the 18,000-kilowatt hydro-electric installation at Naharayim on the Jordan.

By the end of 1948 the military markets had dried up; the inevitable inflation of the Israel pound forced up wages and the cost of imported raw

[1] The development of Histadruth's dual capital-labour personality is one of the most interesting studies in political economics of recent times. It represents all the trade unions and more than a third of the invested capital of the State; for example, the great building cooperative, "Solel Boneh" and the water-pipe and cement factories of "Mekoroth" and "Nesher" respectively are Histadruth organizations.

[2] Horowitz and Hinden, 'Economic survey of Palestine,' Tel Aviv, 1938, quoted by Dr. Willatts, *loc. cit.*

materials and equipment; the Armistice Lines isolated Israel from neighbouring Arab markets, and cheap oil no longer reached the Haifa refinery owing to the action of Iraq in stopping its flow along the pipeline [1] and of Egypt in closing the Suez Canal to merchandise destined for Israel. The influx of skilled Jewish manpower continued, but that of capital for equipment fell off owing to the insistent demands of defence, public works and the settlement of immigrants.

In spite of all these discouraging factors there has been a remarkable expansion of industry since 1948. No less than 1894 new firms, employing 13,000 workers, were founded in 1949 and the first six months of 1950.[2] Of these, 17·4 per cent. represented the metal branch, 16·6 per cent. clothing and shoes, wood-working industries 16·1 per cent., textiles 11·5 per cent. and food 10·3 per cent. A significant feature was the increase in the sale of electric power to industry by the Palestine and Jerusalem Electric Corporations, from 97 million to 140 million kilowatt-hours in 1950. In May 1948 Israel contained factories with a total floor-space of 25,613 square metres; by the end of 1950 the area had increased to 81,236 square metres, and another 115,617 square metres were under construction. Large-scale enterprise has not been confined to the Histadruth; there are several sizable foreign concerns, such as the Kaiser-Fraser car assembly plant at Nathanya and the Sugarman shoe factory at Jerusalem, both American enterprises. But the most notable increase has been in small-scale light industries, for in Israel the importance of the "small man" cannot be over-emphasized.[3] The policy of the present Government, especially since the appointment of Mr. Yaacov Geri as Minister of Trade and Industry, has been to encourage new enterprise and investment in small concerns, chiefly by immigrants, in every possible way. Many of the immigrants belong to communities noted for craftsmanship, such as the Yemenites whose return to Zion "on the wings of an eagle" is one of the real-life romances of modern times. The "Investment Centre" established in June 1950 for the encouragement and regulation of industrial enterprises had by the end of 1950 approved 334 new concerns representing an investment of I£36,526,000; about half of these were financed with foreign capital. Most of them produced goods for the home market, thereby saving foreign currency, but every effort is being made to stimulate the manufacture of goods for export and to reduce home consumption. Foreign currency must be earned on a much larger scale than at present if Israel is to become a viable State, for the trade balance (see Appendix, Table 1) reveals a deficit of I£76,052,475 in 1949 and I£89,432,788 in 1950.

[1] Since August 1950 the Haifa installation of Consolidated Refineries Ltd., a joint enterprise of the Iraq Petroleum Co. and the Anglo-Iranian Oil Co., has been working at a low percentage of capacity on high-cost crude oil from Venezuela.

[2] *Israel Econ.*, March 1951, p. 60.

[3] The distribution by size of the 1894 new firms is as follows:

Less than 5 workers	53·9 per cent.
6–10	27·0
11–30	14·7
31–50	2·2
51–100	1·3
over 100	0·9

To this adverse balance must be added another I£7 million or so for interest, insurance, etc. How does Israel finance this relatively huge deficit?

In a thoughtful article published more than a year ago,[1] but as true to-day, Mr. Peretz Naftali, head of the Economic Advisory Board to the Prime Minister, emphasized the uncertain nature of the sources from which Israel made up her trade deficit for 1949.[2] It is of the utmost importance that Israel should give first priority (apart from defence) to her export trade, cost what it may in effort and austerity in the shape of rationing, reduction in supplies of consumers' goods, and "freezing" or even lowering the scale of wages and social benefits.[3] Her leaders are fully awake to these necessities, and there are already signs that their policy is bearing fruit. The breakdown of imports and exports in 1949 and 1950 (Table 1) shows that the total increase in imports between the two years was 16 per cent.; this compares favourably with the increase in the population which was no less than 24·7 per cent. in the same period. Moreover, the 16 per cent. increase was confined to raw materials for agriculture and industry, fuel and "investment goods," that is to say equipment for factories, farms, citriculture, transportation, etc., and building materials. The value of food and consumers' goods imported actually fell.

As has already been mentioned, the great bulk of Israel's industries is in small units and of the types usually classed as "light." Most of these industries do not depend on the immediate proximity of ports or large centres of population but can be sited in any area adequately served by roads, electric power, water, etc. and a reasonable supply of labour. At present

[1] *Work*, Tel Aviv, July–August 1950.

[2] He assessed these sources as follows:

	Million I£
Gifts, capital transfers and immigrants' personal effects	13·8
Contributions by Jews abroad	30·0
Investments and long term loans	10·0
Export-Import Bank loan	5·0
Other credit	10·0
Services, including tourists (invisible exports) ..	7·0
Sterling balances released by Britain	8·5
Unaccounted for	0·2
Total ..	84·5

The scale of contributions from Jews abroad and foreign credits depends on factors on which Israel has no influence, such as the economic situation in the United States. Released sterling balances are not a recurring item. The capital imported by immigrants varies with the conditions prevailing in their countries of origin.

[3] It is difficult for any foreigner who has been connected with industry in present-day Israel to resist the conclusion that organized labour is getting too large a slice of the national cake. The rise in standard wages since 1939 has far outstripped the rise in the cost of living. The official index is in the region of 325 against 100 in 1939; costs not on the index have to be taken into account, but even so the overall cost of living is not more than 400–450 per cent. higher than before the Second World War. But standard wages are anything from six to ten times what they were then. And that is not all: "social" benefits have increased, and the men get more piece-rate earnings, more overtime, and much more liberal grading than in the past. Their living standard to-day is not as high as in the U.S. or Britain certainly, but it is higher than in many civilized countries with better-balanced economics. This does not apply to immigrant labour in the *ma'abarot*, see footnote 1 to p. 316.

most of the country's factories are concentrated in or near Tel Aviv and Haifa, a distribution of industry which is rightly described as unnecessary and inefficient. But it is going to be far more difficult to persuade the promoters of new industries to establish them far from the main centres of population than it is to direct streams of individual immigrants into remote rural areas, and for this reason the establishment of "industrial estates" has been decided on by the Government. These are described as "zones reserved for industrial development which have been planned in advance and equipped with all the necessary facilities, *e.g.* roads, water supply, drainage, electric light and power, repair workshops and all the other installations and services necessary for the efficient operation of the factories and the welfare of the workers." Such industrial estates have already been started at Jerusalem, Ramleh, Nathanya, Kefar Saba, Ra'anana, and Rehovoth.

Israel, so dependent on imported raw materials for her industrial expansion, has one "mine" of inestimable value—the Dead Sea. In the Negev and elsewhere deposits of limestone, asphalt, sulphur, gypsum, manganese, ochre, ceramic clays, and quartz have been worked, experimentally or on a small commercial scale, but only kaolin and quartz are being worked at present in the so-called "Deep Canyon" south of Beersheba. No coal has been found, and prospecting for oil has not yet borne fruit. On the other hand, the prospect of extracting industrial chemicals from the Dead Sea is very hopeful. Under the Mandate, the Palestine Potash Co., a British company, operated two plants for the extraction of potassium salts, one at Kallia at the northern end and the other at S'dom near the southern end. The Dead Sea, which lies 1286 feet below ocean level, contains a stronger concentration of salts in solution than any other large natural body of water in the world,[1] and the importance of its potassium content as a raw material for fertilizers may be judged from the fact that grain crops extract from 50 to 100 kilogrammes of potassium from a single hectare (2·47 acres) of land, and potatoes from 200 to 300 kilogrammes. The high proportion of magnesium chloride is also a valuable asset, especially in these days of vast armaments, but its economic extraction depends on cheap power which is not at present available. The magnesium bromide on the other hand is of importance, as it is a component of ethylene diabromide, the "anti-knock" element in aviation fuel.

During the hostilities of 1948 the Kallia plant, situated in what is now Jordan territory, was entirely demolished, but the S'dom works which had produced between 60,000 and 70,000 tons a year (40 per cent. of the total output) remained intact and in Jewish hands. Negotiations are in progress between the company and the Israel Government for the resumption of its operations. A loan of $2\frac{1}{2}$ million dollars has been approved by the Export-Import Bank, and a road is being constructed from S'dom to Beersheba

[1] The estimated content of the water is:

Potassium chloride	2,000 million tons
Magnesium chloride	22,000
Magnesium bromide	980
Calcium chloride	6,000
Sodium chloride	11,000

which will facilitate the transport of potash to Migdal Gad on the coastal railway and thence to Haifa.

Planning for the future

The agricultural and industrial development described above has not been achieved without a considerable measure of direction and planning by the Jewish Agency, and also by the Planning Division of the Israel Government which staged an Exhibition at Tel Aviv in the spring of 1950.[1] The picture is of an Israel of $2\frac{1}{2}$ million inhabitants, not concentrated as in the past in three cities and the coastal region between Tel Aviv and Haifa,[2] but distributed in 24 "planning regions," three of them urban and twenty-one rural. It is not proposed to transfer large numbers of people, but to direct the stream of immigrants into underpopulated urban and rural areas. The main features of the overall plan can be seen in the map (Fig. 8 on the folding sheet).

An agricultural population of 500,000 (20 per cent. of the whole) is aimed at. It is noted that the corresponding proportion in Holland is 20·5 per cent. and in Switzerland 20·8 per cent. Distribution is planned on the basis of the country's agricultural capacity.[3] An elaborate irrigation scheme covering the whole country has been prepared which will "allow extensive new areas to be brought under cultivation and enable local agriculture to produce up to 80 per cent. of the country's requirements, and to provide it with its staple export of citrus and certain other agricultural commodities."[4]

As regards urban development in the future, a population of 450,000 is envisaged for Tel Aviv, centre of commerce and industry; 300,000 for Israel's chief port, Haifa; and 250,000 for the capital, Jerusalem. Their present populations are estimated at 330,000, 160,000 and 120,000 respectively. In addition there will be 12 "medium-sized" towns averaging 50,000 and 12 "small townships" with from 15,000 to 30,000 inhabitants. These 24 towns, or most of them, will be the urban centres of their respective "planning regions" and the seats of their regional administrations.

The decision to make Jerusalem the national capital, reached by the Knesset while the United Nations were still deliberating whether to internationalize it or not, proved a powerful stimulus. The Municipality headed by its able Mayor, Mr. Daniel Auster, the Israel Government represented by Mr. M. Schattner, and the Jewish Agency through their representative Mr. Nebenzahl, collaborated to float a "Jerusalem Economic

[1] Described by the Director, Mr. Arieh Sharon in an illustrated article in *Israel and the Middle East*, March–April 1950, pp. 41–56.

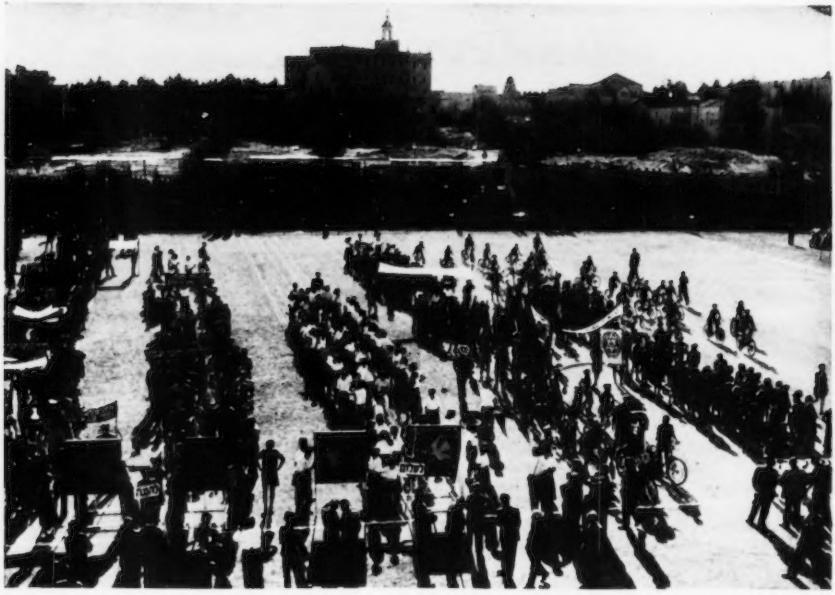
[2] Something like a third of the population is even now concentrated in Tel Aviv and its immediate hinterland.

[3] Vogt in 'Road to Survival' (p. 16) describes the agricultural or "carrying" capacity of a piece of land as the resultant of the ratio between its "biotic potential" and the "environmental resistance" which limits its productivity. He mentions Palestine by implication as a case of high environmental resistance ruining the land (p. 10).

[4] Since 1938, five of the twelve "regional systems" of the Irrigation Plan have been initiated: Western Galilee, supplying Haifa Bay and City; Kishon or Central Emek, supplying the Jezreel valley and Affuleh; Karkur-Pardess Hanna, supplying Hadera, etc.; Lydda Plain, supplying Jerusalem from the Ras el Ain springs; The Negev System, supplying Beersheba and Gevulot from springs at Nir Am, 6 miles east of Egyptian-occupied Gaza.

Nahalal, a typical communal settlement (kibbutz) of about 30 years' standing

Kefar Yehezqel, a cooperative settlement (moshav ovdim)



Rally of Jewish youth, May Day, 1950. Terra Sancta College, the temporary headquarters of the Hebrew University, in the background

The Apostolic Delegate and the Latin Patriarch at the Church of the Nativity, at Bethlehem, Christmas Eve, 1949

Corporation" which took in hand the encouragement and planning of the city's industrial development. By the end of 1950 two hundred factories and workshops, including a large modern shoe-factory on American lines, a pharmaceutical plant, a cigarette factory and a cooperative pottery works, had been set up with the help of the Economic Corporation. In accordance with the Government "Industrial zone" policy (see page 321) an area of 100 acres fully equipped with water, light, power, drainage, roads, etc., was established at Romema on the city's highest hill-top and is already in use by factories and industrial premises.[1]

Foremost among the plans for the future are those for government offices and Parliament buildings in the new Kirya (seat of government) on the Givat Ram hill, and the Convention Centre which is to house the next Zionist Congress. As has been mentioned above an eventual population of 250,000 is being catered for and an elaborate and ambitious, but highly practical, plan of the future Jerusalem has been prepared (Fig. 6).[2] The area included is 9500 acres, more than 60 per cent. greater than the present urban area under Jewish jurisdiction. The focal point will be the Givat Ram ridge; the hill-tops to the west and south, except Mount Herzl which is to be a memorial park to the great Zionist leader, are to be occupied by residential suburbs. The valleys between these ridges are to be planted with trees and gardens to make a series of "green belts" round each built-up area. A still more ambitious afforestation scheme is to plant 50,000 acres of barren uplands in the Corridor. Mention has already been made (page 316) of the Work Villages (*Kafrei Avoda*) established by the Jewish Agency; some 3000 immigrants, mostly Yemenites, are being employed on this work as well as on the preparation of another 60,000 acres of better land for farming, fruit-growing, etc. The cost of this scheme, which will require some 7 million "work-days" of labour, is estimated at I£12,000,000 and will be borne by the Jewish National Fund. The total agricultural population aimed at for Jerusalem's "hinterland" is 11,500 families. Other projects include the doubling of the city's water-supply by means of a second pipeline from Kefar Uriya (see page 314), the building of a new Medical Centre for Hadassah, and the construction of a branch railway line up the Wadi Sarar to serve new cement, brick and stone-cutting works in the Corridor.

A gallant effort is indeed being made to refashion worthily a Jerusalem maimed and truncated by the necessities of partition. But the Holy City cannot prosper materially nor regain its rightful status as a great natural centre of population until peace is made between Israel and the Kingdom of the Jordan and an undivided Jerusalem can function once more as an entrepôt between the coast and the Jordanian hinterland and a goal of pilgrimage from the four quarters of the earth.

[1] See M. Schattner "Experiment in reconstruction," *Israel and the Middle East*, November–December 1950, pp. 143–6, and a paper by Atieh Sharon in the same issue; also Mr. Sharon's article on the same subject in the March–April 1950 number.

[2] See folding sheet.

APPENDIX

Table 1. *Israel's foreign trade in* 1949 *and* 1950

Exports	1949 (I£)	*per cent.*	1950 (I£)	*per cent.*
Citrus	6,445,024	60·5	6,051,754	46·0
Citrus by-products	863,623	8·1	505,497	3·8
Diamonds	1,853,987	17·4	3,146,702	23·9
Woollen products	27,807	0·3	914,313	7·0
Apparel	71,879	0·7	337,883	2·6
Artificial teeth	182,335	1·7	307,914	2·3
Chocolates and sweets	40,813	0·4	226,640	1·7
Cotton products	21,860	0·2	125,853	1·0
Pharmaceutical products	22,278	0·2	92,551	0·7
Wine and liquors	68,432	0·6	64,223	0·5
Essential oils	120,161	1·1	52,293	0·4
Other goods (mostly industrial products)	458,655	4·3	726,792	5·5
Unspecified	482,689	4·5	609,797	4·6
Total	10,659,543		13,162,212	

Imports	1949 (I£)	1950 (I£)	*Change per cent.*
Consumers' goods:			
Food	13,522,000	13,118,000	− 3·0
Other non-durable	9,636,000	9,212,000	− 4·4
Durable	5,002,000	4,453,000	− 9·0
	28,160,000	26,783,000	− 4·9
Agricultural raw materials	5,661,000	5,900,000	+ 4·2
Industrial raw materials	22,927,000	26,772,000	+16·8
Fuel	5,294,000	7,694,000	+45·3
Investment goods:			
Industrial equipment	6,077,000	8,531,000	+40·4
Agricultural equipment	5,801,000	9,417,000	+62·3
Transportation equipment	856,000	892,000	+ 4·2
Other equipment	5,356,000	8,266,000	+54·3
Building materials	6,807,000	8,115,000	+19·2
	24,897,000	35,221,000	+41·5
Unclassified imports	773,000	235,000	
Total	87,712,000	102,605,000	+17·1

Table 2. Countries of origin of the first half-million immigrants (May 1948–December 1950)

Europe			
Poland	104,856	20·4 per cent.	
Rumania	79,665	15·5	
Bulgaria	37,745	7·3	
Czechoslovakia	19,221	3·7	
Hungary	14,070	2·7	
Germany	7,901	1·5	
Yugoslavia	6,938	1·4	
Russia *	3,852	0·8	
Austria	2,579	0·5	
Greece	2,109	0·4	
Baltic countries *	1,375	0·3	
Other European countries	9,998	1·9	
	290,219		56·4 per cent.
Asia			
Yemen and Aden	51,581	10·0 per cent.	
Turkey	35,843	7·0	
Iraq	28,216	5·5	
Persia	13,953	2·7	
Lebanon and Syria	2,934	0·6	
Afghanistan	543	0·1	
	133,070		25·9 per cent.
Africa			
Tunisia, Algeria and Morocco	36,431	7·1	
Libya	25,199	4·9	
Egypt	14,626	2·8	
	76,256		14·8 per cent.
Other Asian and African Jews	6,379		1·2
North and South America	2,560		0·5
Origin not specified	6,169		1·2
Grand total	514,653		100·0

(* From DP camps in Germany, Austria and Italy).

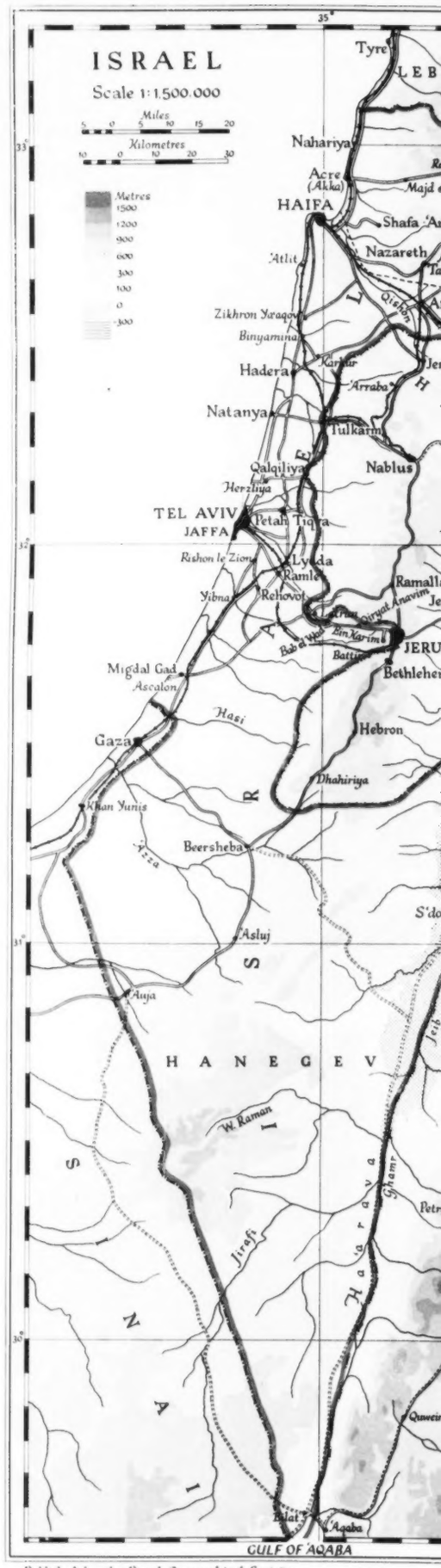


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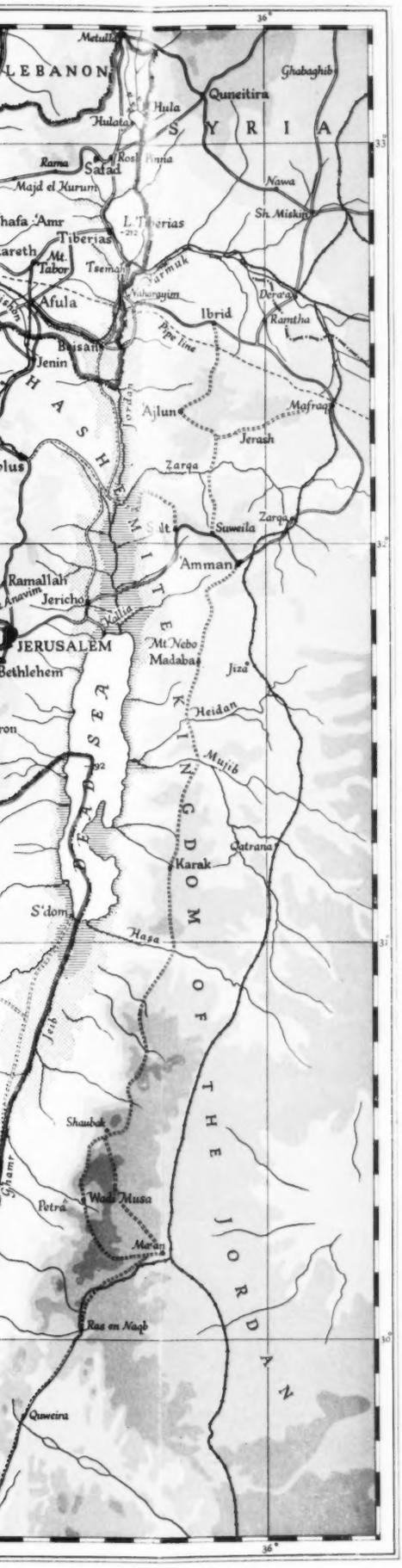
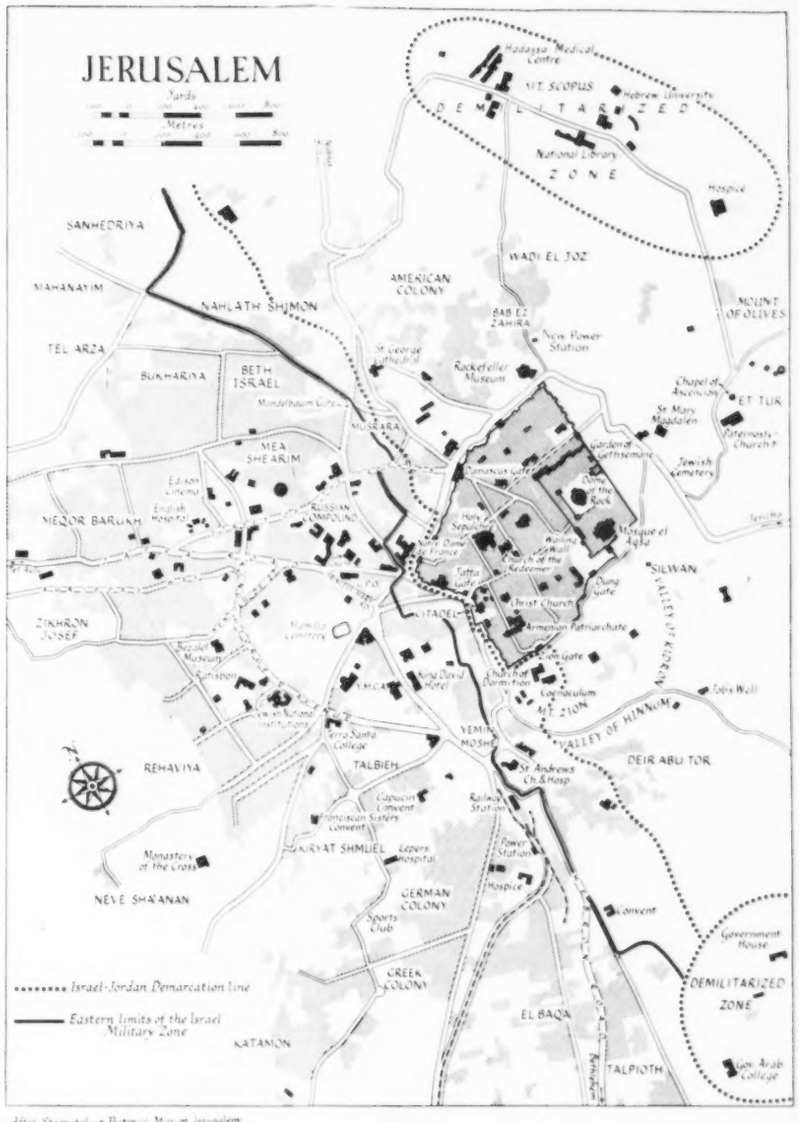
Figure 4



gure 4



After Stematzky's Pictorial Map of Jerusalem

Figure 5

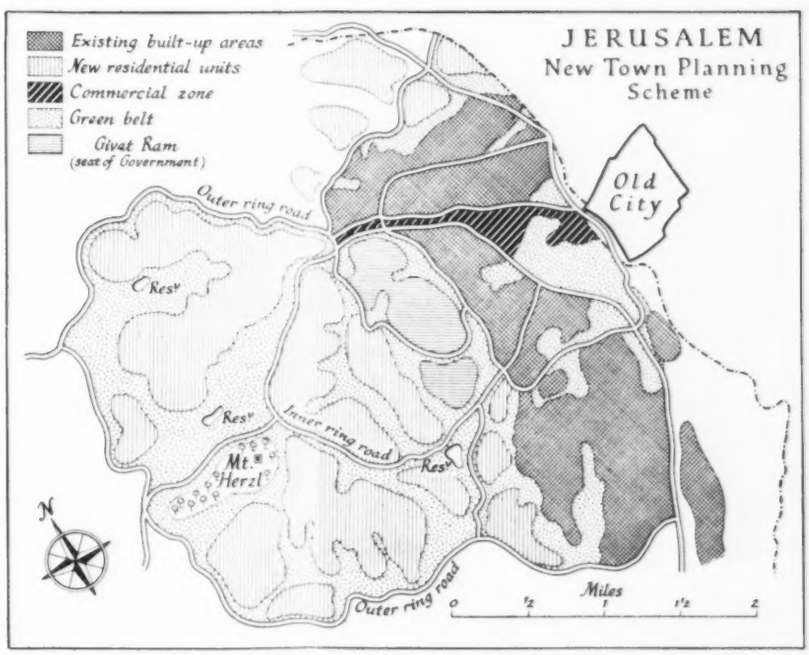


Figure 6

SKRINE

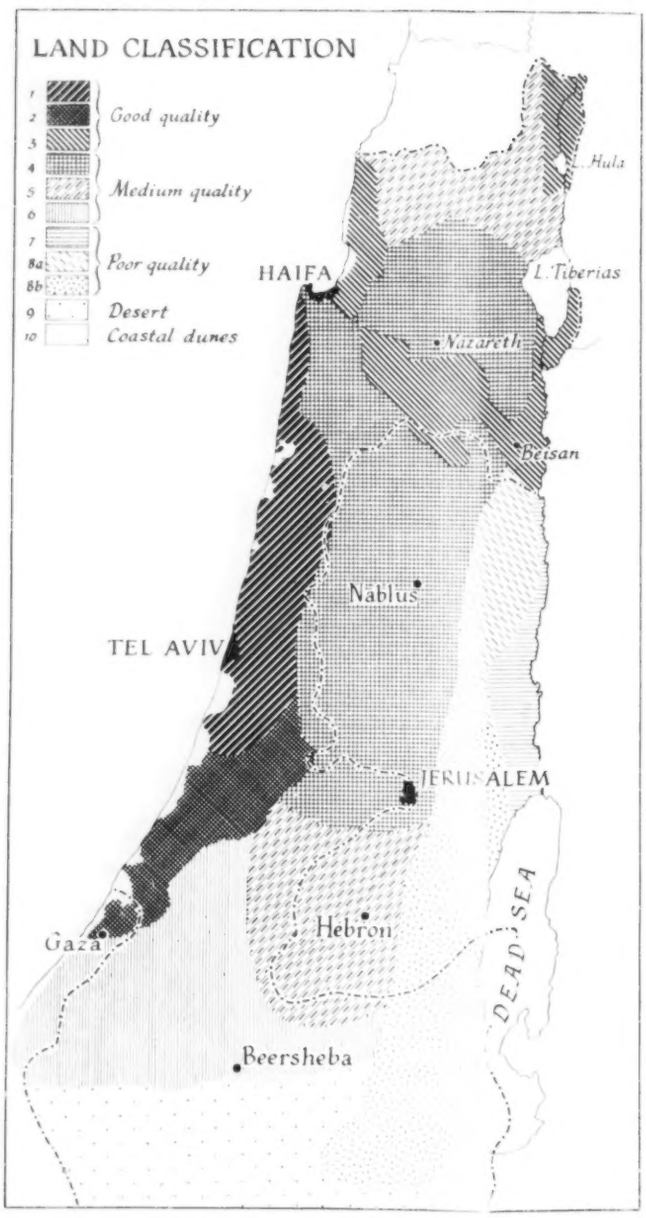


Figure 7

Figure 8

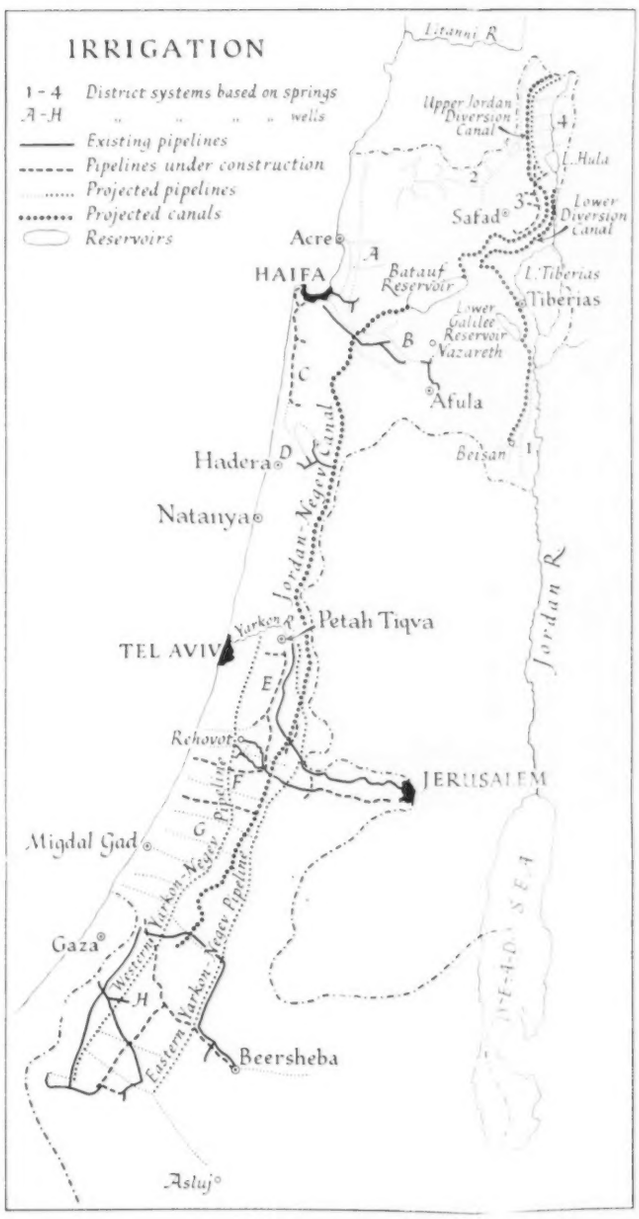

IRRIGATION
1 - 4 District systems based on springs
A - H " " " " wells
Existing pipelines
Pipelines under construction
Projected pipelines
Projected canals
Reservoirs
Litanni R.
Upper Jordan Diversion Canal
L. Hula
Safad
Lower Diversion Canal
Acre
HAIFA
Bataut Reservoir
L. Tiberias
Tiberias
Lower Galilee Reservoir
Nazareth
Afula
Hadera
Beisan
Jordan-Negev Canal
Natanya
Jordan R.
Yarkon R.
Petah Tiqva
TEL AVIV
Rehovot
JERUSALEM
Migdal Gad
Gaza
Western Yarkon-Negev Pipeline
Eastern Yarkon-Negev Pipeline
Beersheba
DEAD SEA
Asluj

Figure 9

Table 3. *Former occupations of the first half-million immigrants (May* 1948–*December* 1950)

Professions	2·1 per cent.
Commerce and finance	2·0
Office workers	1·9
Transport and communications	1·0
Agriculture, forestry and fishing	0·8
Services	0·2
Other crafts	11·1
Unspecified	1·3
Children under 16	26·8
Students over 16	1·4
No previous occupation or training	51·4
	100·0

DISCUSSION

Evening Meeting 16 *April* 1951

Before the paper the PRESIDENT (Sir HARRY LINDSAY) said: It is with great pleasure that I introduce an old colleague of mine, Sir Clarmont Skrine. He and I spent the best years of our lives in India. Sir Clarmont chose the political side; he went first to South Persia and then to Baluchistan; he had experience in Sinkiang and also in the Chinese Pamirs. He was Resident in the Madras States and also in the Punjab. He was Consul-General at Meshed and, until 1948, Counsellor for Indian affairs at our Tehran Embassy. Since then he has been the representative at Jerusalem of the London Board of the Jerusalem Electric Corporation. His experience is thus extremely wide.

Sir Clarmont Skrine then read his paper

The PRESIDENT: We are immensely grateful to you, Sir Clarmont, for what you have told us and for the beautiful films you have shown. We are fortunate in having with us this evening H.E. the Israeli Minister at the Court of St. James's. We should be grateful, Your Excellency, if you would contribute to the discussion.

H.E. The ISRAELI MINISTER: I consider it a very great privilege indeed to have been invited to attend a meeting of this distinguished Society. I feel sure all will agree with me that we have listened to an excellent and comprehensive presentation of economic developments in Israel and some of the problems involved. It has been brought home to me, what I believe has long been known as a fact, that one actually knows very little of one's own country and can always learn more and more. The description to which we have listened and the beautiful pictures aroused in me somewhat nostalgic feelings, especially when Sir Clarmont showed pictures of the city of Jerusalem where I spent a great part of my life. I should like to say how grateful we are to Sir Clarmont for his lecture.

Mr. ERIC BERGSTROM (Consulting Engineer to Messrs. Balfour Beatty and Co.): I can only endorse what has already been said in thanking Sir Clarmont for his most interesting and instructive description of the present developments in Israel. I have been privileged to visit Israel on several occasions during its now three-years'-old independence, and I can testify to the outstanding progress made in such short time, progress which must be seen to be believed.

Whilst Sir Clarmont has so admirably covered, within the limited scope of his address, the economic developments in so many spheres of activity, I think he has not done sufficient justice to the great progress in connection with the improvements and extensions of the highway systems and the provision of electricity for all purposes. Scientists and engineers are now at work to explore the untapped resources of the country, but for the commercial exploitation of these resources adequate transport and electric power are essential prerequisites. As regards transport, apart from improving and widening the existing highways, new roads are rapidly being constructed to meet the requirements of areas under development, particularly in bringing the Negev within easy access of the central plains.

In the case of electricity, the consumption of which is a generally accepted index of progress, industrial or otherwise, it might be stated that the consumption has been practically doubled during the last three years, or from 250 million kWh. in 1948 to, approximately, 500 million kWh. in the current year. This amount would have been greatly exceeded but that extensions to the generating capacity could not keep pace with the rapidly growing demand. The present installed capacity of the public utility undertakings amounts to approximately 140,000 kW. and a further 100,000 kW. is now under construction, and scheduled to be in operation in 1952–53; but even this additional capacity will only meet the potential demand now unsatisfied and further extensions are being planned.

Whilst this progress in all fields of activities has been stimulated by the "open door" policy in Israel (to absorb all kindred people from far distant lands desiring to settle permanently in the country) it cannot be denied that this policy has caused a financial strain which has disturbed economists the world over as a situation almost insuperable, judging from the present balance sheet of the new nation.

That the financial situation is precarious is admitted, but it can be argued with a great deal of conviction that the present phase of development in Israel cannot be measured by normal economic standards. The reason is that Israel has now her own sons and daughters returning from exile, equipped with the technique and skill to participate in this great task of reconstruction; inspired by high purpose and with the will, supported by Jewry the world over, to succeed in the re-establishment of its historical position in the Holy Land against the formidable economic difficulties standing in the way. There can be no doubt that, given peace and political security, Israel will play an important role as an integral part of the economy of the Middle East, and thereby contribute in no small measure to the well-being and development of this at present disrupted region.

The progress now being made in the development of Israel's resources will justify the economic absorption of many more thousands of displaced persons of Jewish origin, a process which, in the end, will pay a handsome dividend. This reminds me of an old Chinese proverb: "If you are planning for one year sow grain; if planning for ten years plant trees, but when planning for a hundred years, grow men."

The PRESIDENT: You have already expressed your feelings on this extraordinarily interesting lecture by Sir Clarmont Skrine. It now only remains for me to propose a very hearty vote of thanks to him for the interesting evening he has given us.

HYDRO-ELECTRIC POWER IN WESTERN EUROPE

ALICE F. A. MUTTON

WHILE THE USE of atomic energy for industrial purposes remains a matter for speculation and research, the need to utilize the inexhaustible supplies of motive power that are derived from falling water is being increasingly emphasized in western Europe.[1] This paper is particularly concerned with recent developments in Switzerland and France. In France impoverishment resulting from the war has made imperative the conservation of internal resources of fuel and the dollar exchange shortage has restricted imports of coal and petroleum from the New World. Whereas before the war the United States of America produced 1117 kWh.[2] of electricity per head per year, Switzerland generated 635 and France 433. Moreover, in spite of the early development of '*l'houille blanche*' in the French Alps,[3] more than half of France's supplies of electrical current are derived from thermal stations burning high grade coal and some lignite. On her liberation France evolved, under the Monnet Plan, national schemes for the production of electricity to increase the output to 1000 kWh. per head as early as 1951. Two-thirds of the increased output is to come from hydro-electric stations, the remainder to be generated in steam plants burning coal, lignite or blast furnace gas, with very little use of imported high grade coal. Most electrical undertakings have come under *l'Électricité de France*, though private firms are responsible for the construction of new works, such as those on the Rhône, the Allier, the Dordogne and the upper Isère. Switzerland, with increased demands for electricity resulting from the war-time expansion of industry and increased transport and domestic needs, launched a ten-year plan in 1946. New hydro-electric installations are designed to restrict the import of coal to a minimum, although the need for large thermal stations in towns such as Basle and Zürich must remain.

These national schemes must be considered in relation to the European Recovery Programme,[4] which recommended nine new undertakings for France, Italy and the Austro–Swiss–Italian border, together with two thermal stations in Germany and a geothermic plant in the region of Vesuvius. These stations were to be completed within four years. Some schemes on a supra-national scale at present being implemented are dealt with in the latter part of this paper: they bear such regional names as *Eytherma*, a project nearing completion in the upper Dordogne valley: *Enytrac*, in the southern Auvergne and

[1] Although up to the present hydro-electric schemes have involved the control and utilization of suitable inland streams and rivers, it has been suggested that the great tidal ranges of the Bay of St. Malo might be exploited, on similar lines to the Severn barrage scheme.

[2] Kilowatt-hours. One kilowatt is equivalent to about 1·34 horse-power.

[3] R. Blanchard: "L'industrie de la houille blanche dans les Alpes françaises," *Annales de Géographie*, 26 (1917) 15–41.

[4] Committee of European Economic Cooperation, *General Report*, 1947. vol. I.

the Cévennes: and *Emalp*, in the French Alps (Fig. 1). In Switzerland, regional schemes to increase supplies have been projected for the Val Maggia (Ticino), la Grande Dixence (now in progress), the Val d'Anniviers (Valais) and the upper Aar and Reuss valleys. Even when these schemes are implemented supplies will not equal the domestic demand, hence the Swiss interest in the *Emalp* scheme, based on the Val d'Isère site. This long term project involves the Swiss sites known as the Super-Dixence, Super-Grimsel and Super-Urseren, discussed later, which compare in scope with the great regional planning developments in the United States carried out under the Tennessee Valley Authority.

The marked increase in the production of electricity in western Europe since the war, compared with 1938, is very striking. The figures in Table 1 are irrespective of type of generator, but in France, Italy and Switzerland the increase is almost entirely due to new hydro-electric installations. The seasonal variation in output, which these schemes have been designed largely to overcome, is illustrated in Table 1 B. In Switzerland, where most of the generation is hydro-electric, the problem of the decreased flow in late autumn and winter is well brought out. In France, on the other hand, where the large power stations, as in Paris and Marseille, are run on coal, the variation in the hydro-electric output from region to region is masked. There is an overall minimum in summer and autumn but the summer minimum affects stations in the Massif Central, the eastern Pyrenees and the Provençal Alps; whereas those in the Swiss Alps and Dauphiné and Savoie suffer from the winter freeze, and stream flow frequently falls to only 30 per cent. of the annual mean at the

Table 1

A. Monthly average production of power (millions of kWh.[1]*)*

	1938	1948	1949 (*first 6 months*)
Germany (U.K. and U.S. zones)	2292	2417	2936
France *	1564	2297	2302
Italy	1095	1635	1434
Belgium	438	659	683
Switzerland †	446	720	630
Netherlands	295	455	475

B. Monthly average production in 1948.[1]

	Jan.–Mar.	*April–June*	*July–Sept.*	*Oct.–Dec.*
France * ..	2345	2316	2256	2270
Switzerland ..	688	722	809	662

* Hydro-electric plants with a capacity of over 1000 kW. and thermal plants with a capacity of over 5000 kW.

† Public utility production only.

[1] *Economic Bulletin for Europe*, vol. 1, no. 2, Economic Commission for Europe, Geneva, 1949.

time of peak industrial and domestic demand, which is particularly marked in the towns of the Swiss Foreland. A similar shortage is felt in the industrial towns of Grenoble and, to a less marked degree owing to thermal stations, Lyon. In the Mediterranean region, where the minimum flow is in summer, hydro-electric supplies have to be supplemented by the large thermal stations of Marseille and Nice.

The present utilization of hydro-electric resources

In 1947 Switzerland produced 10,450 million kWh. of current, 71 per cent. being generated at 285 hydro-electric stations and the remainder from coal or lignite, mainly imported. By 1951, production will be stepped up to 12,700 million kWh. but will still be unequal to the demand, so that the supply available for export in the near future is limited. The three-fold increase in production in the last thirty years has been brought about by the completion of a number of large installations in the Alpine valleys and along the upper Rhine between lake Constance and Basle, as well as by smaller stations on the Mittelland and in the Jura valleys (see folding map).

The Swiss Alps. Conditions here are almost ideal. High gradients, up to almost 100 per cent. where hanging valleys occur, the abrupt breaks of slope characteristic of glaciated valleys at the *verrous* or *riegels*, and a heavy mean annual precipitation, frequently exceeding 80 inches per annum, are the basic factors. Although precipitation is well distributed through the year, with heavy winter snowfall on the Alps and a continental summer maximum rainfall, the winter run-off is checked by freezing and moisture is conserved in the great snowfields. The flow is indeed then much reduced and some stations use imported coal as a stand-by in small thermal units; in spring the flow may increase suddenly through snow melt caused by a rise in temperature associated with the *Föhn*. Where streams depend on melting snow and ice, their regime is of a nival type [1]; the maximum flow is in June and July, declining in late summer to reach a minimum in January and February. The decline in supplies of electricity during the winter months, which is the inevitable consequence, has already been noted.

In the High Alps, where limestones are largely absent, losses by percolation are low and evaporation is reduced to a minimum owing to high gradients; the run-off may equal 70 to 80 per cent. of the total precipitation. Thickly forested slopes, especially characteristic of the Calcareous Alps, the lower slopes of the Pennine Alps and the St. Gotthard and Aar massifs, also affect the volume of stream flow, and high level cirque lakes, like the Grimsel, have served as natural regulators in the past. Today, artificial storage basins are becoming increasingly essential where large power stations are to be kept regularly supplied. These reservoirs have been created at several sites, such as the Grimsel above the Aar valley, the Gelmersee above the rock bar or *verrou*, at the Handeck Falls, and also behind the Barberine barrage south-west of Martigny near the French frontier (see map). These reservoirs serve as basins of accumulation in summer and as compensators in winter.

Most Alpine stations achieve their high output by using the maximum head

[1] E. de Martonne: *Géographie Physique*, tome I p. 477.

available, water being diverted from the upper reaches of a stream to penstocks which descend the steepest available slope. Where these pipe lines are underground there is little interference with the scenic amenities of the valleys. At the Dixence site, in the western Pennine Alps, a fall of 528 feet generates 131,250 kW.: at Ritom, on the Ticino, a fall of 260 feet produces 45,000 kW. (Plate 4): and at the Barberine station, a fall of 239 feet produces 36,750 kW. The site of this latter barrage is a rock bar above the great post-glacial gorge cut by the Trient stream which is followed by the spectacular road from Chamonix to Martigny.[1]

The Swiss Mittelland. Apart from the large number of relatively small stations located on streams draining mainly northwards to the upper Rhine, the chief features of interest concerning the Swiss *Mittelland* or Foreland lie in the frontier regions (see map). The station at Chancy Pougny below lake Geneva has been in operation for some years.[2] Here the great volume of water, regulated by the natural reservoir of the lake, compensates for a head of only 25 feet, and the capacity is 35,250 kW. The plants on the upper Rhine, between Basle and the Rhine Falls, also use low gradients with a regular flow and large volume of water. At Ryborg-Schwörstadt, on the Swiss–German frontier above Basle, a drop of only 28 feet is used to produce 105,000 kW.; and at the Laufenburg station farther upstream, 54,000 kW. is generated with a fall of only 20 feet. The power stations dependent on the Rhine Falls below Schaffhausen supply current to the pre-war aluminium works at Neuhausen, though the plant was damaged by aerial bombing during the war and is still not working to full capacity.

The Swiss Jura. Hydro-electric power, important though it is to local industry, is here on a scale small compared with the Alps and the upper Rhine valley. The lack of permanent snow and ice, the small catchment areas and the few suitable sites restrict power stations to a series of small plants along the chief streams, such as the Aar below Biel and the Areuse, which drains the Val de Travers into lake Neuchâtel. In the south-west of the Jura small stations supply the industrial town of Vallorbe, but the industrially important towns are piedmont sites such as Neuchâtel and Biel.

The French Alps. There is a marked lack of coal in the French Midi, except in the Cévennes (Alès field), in the Rhône delta at Fuveaux and in the Hostens field south of Bordeaux, where lignite is exploited for use in the local power stations. Physiographically, that part of France which lies south of a line from Strasbourg to Nantes is most favourable to the development of hydro-electric power (see map). The early use of '*l'houille blanche*,' as the French geographers describe it, is associated, of course, with Alpine France. As in the Italian Piedmonte, so in Savoie and Dauphiné the power stations which were the first to be built are in remote Alpine valleys such as the upper Isère, Romanche and Arc. In Haute Savoie and Dauphiné snow may be expected on

[1] E. de Martonne, 'Europe Centrale,' tome II, *Géographie Universelle*, 1931, p. 442. Cotton, C. A.: 'Climatic accidents in landscape making,' 1942, p. 233.

[2] J. Früh, 'Der Schweiz,' vol. 2, p. 338.

the average on 30 days in the year up to 3000 feet, on 50 to 60 days at 6000 feet and on 80 days above that elevation, where snow may fall on any day in the year. In the Pre-Alps the snowfall is relatively heavy, as the result of westward exposure, with falls on 50 days in the year, a figure which compares with the average for the western Pyrenees and the Haute Auvergne. Heavy precipitation, well distributed throughout the year in the northern French Alps, associated with magnificent stands of timber, especially on the Pre-Alps of Savoie and Dauphiné, and the steep gradients and broken *talweg* of glaciated valleys, all favour the establishment of hydro-electric stations designed to use a high head of water to generate a comparatively small amount of power. During the last seventy-five years the extreme inaccessibility of the sites has been mitigated by building metalled roads or railways so that industries have developed; the raw materials, such as bauxite, come from elsewhere. The Isère valley above Moutiers has the additional advantage of workable coal in the neighbourhood and this is used to supplement hydro-electric power in the industrial works established between Ugines and Albertville, where the Arly joins the Isère from the north. Electro-chemical and electro-metallurgical industries are important in the Grenoble region as well as at Moutiers in Tarentaise, and at Modane in Maurienne. Peasant agriculture has also reached a comparatively high level of prosperity through the opening up of some of these Alpine valleys, notably Grésivaudan where the standard of living compares with the Swiss Valais between Martigny and Brigue. In the more remote valleys, such as Haute Maurienne, the pylons carrying high tension cables are in striking contrast with the primitive wooden châlets of the Savoyard peasant. Nevertheless, although the peasants and the cattle divide the ground floor between them during the winter months, electricity now provides the lighting.

Since the demand for current on a large scale lies partly outside the Alps, as in Lyon and its dependent industrial establishments, most of the older plants in the Alps are now linked to the main grid which distributes current across south-eastern France. To achieve a regular output, the large modern stations depend on reservoirs to regulate their supply of water. A striking example is the Chambon barrage on the Romanche, completed in 1938. This reservoir regulates the flow of water to a small power station, with a capacity of only 2070 kW. though the head is one of the highest in the French Alps.[1] The winter flow to the turbines has now been doubled and power is distributed by high tension transmission to regulate the variable output of older installations in the region. In Provence on the other hand, where the minimum flow is in summer, the post-war years have seen the completion of the Castillon barrage on the Verdon river, a headstream of the Durance (Plate 1). This station has a potential capacity of 80 million kW. and, in addition, water may be diverted from the storage basin behind the dam to the irrigated lands of southern Provence. Plate 1 shows the considerable fall in the level of the reservoir during the intense drought of the summer of 1949. Here, as is usual in limestone regions, loss by percolation has also proved a serious problem and the fissures had to be closed by grouting.

[1] A. Demangeon, 'La France,' tome VI, *Géographie Universelle*, p. 686.

The French Jura and the upper Rhône valley. In western Europe, as in the United States before the war, the advantage of using the great volume of water in a swiftly flowing river has been fully realized. In France, both the Rhône and the Rhine are suitable for the construction of barrages of considerable length but of no great height. The regime of the Rhône is "alpine" as far as the delta at Arles, with a summer maximum flow and a winter minimum. The flow of the Rhône at Génissiat, the site of the recently completed barrage, is 200 cubic metres per second. The scheme at present being implemented involves therefore the control of a turbulent river for navigation and the prevention of floods, as well as the generation of electricity for the Lyon industrial region and the P.L.M. line, now being electrified from Paris to Lyon. The electrification of the Paris–Dijon section was completed in 1950.

In 1933, the *Compagnie Nationale du Rhône* [1] was charged with the task of carrying out a regional plan comparable with that of the Tennessee Valley Authority. Now that electrical undertakings have been nationalized, the company is operating under *l'Électricité de France*. Before the war, work was begun on a site 30 miles below the Swiss frontier; but it ceased abruptly in 1940 when the Rhône was allowed to flood the nearly completed structure. Work was begun again in 1945, with the aid of foreign and North African labour, and the Génissiat dam completed three years later. The installation is the largest completed work of its kind in western Europe and second only to that of Dnieprostroi in the Eastern Hemisphere.

The site of the barrage presents special features. Highly folded Jurassic rocks underlie the dam and steep limestone cliffs form the walls of the gorge on either side of the barrage. Sited 990 feet above sea-level, the dam is 315 feet high and 400 feet long. The power station is built into the base of the dam, partly to utilize the maximum fall through the penstocks, but also to secure some immunity from aerial bombing. There are six intake towers, rather in the style of the Hoover or Boulder dam in Arizona, leading by a drop of 213 feet to the turbo-generators below. Each of these has a potential of 65,000 kW. and four were in operation in 1950, two others having yet to be completed. The capacity of the station will eventually be nearly 400,000 kW., four times that of the largest Swiss station on the Rhine at Ryborg-Schwörstadt. The annual output of the station, estimated to reach 1800 million kWh., will equal one-fifteenth of France's present consumption of electricity and 10 per cent. of her total hydro-electric output.

The dam at Génissiat is approached by railway from Lyon up the Rhône valley via Culoz, a narrow ledge on the northern side of the gorge providing sufficient space for the track. A road is being built over the crest of the dam to replace the bridge at Bellegarde, destroyed when the 14 mile long reservoir was created upstream. During the construction of the barrage, the Rhône was diverted through two underground lateral tunnels, larger than the Paris Metro in circumference, and today a great spillway ends in a spectacular cascade on the north side of the dam. This spillway is designed to carry away silt, so that it does not accumulate at the face of the dam.[2] The problem of the Rhône is not however solved, for the river has no potential reserve flow. The capacity

[1] Data supplied by the Compagnie Nationale du Rhône, Lyon, 1949.

[2] Compagnie Nationale du Rhône: 'Aménagement de la Chute de Génissiat, 1947.

of the turbines is greater than the minimum flow and, although lake Geneva serves as a natural regulator, the river frequently falls below this mean minimum in winter. The compensation basin under construction at Seyssel, between Génissiat and the Swiss frontier, is designed to augment the winter flow. As a long term project, the additional flow to be derived from the Val d'Isère reservoir, via the power station below Martigny, will greatly benefit the Génissiat station.

The lower Rhône valley. Another major work on the Rhône now in hand is at Donzère-Mondragon, above Montélimar, where the river has eroded a defile in Cretaceous limestone. This work has recently been declared an urgent public utility; the Rhône is to be made navigable above Lyon, where a river port, named after M. Edouard Herriot, was opened in 1937 and serves to provide new wharfage and factory sites. In the neighbourhood of Donzère–Mondragon, water is to be diverted by pumping to extend the area under irrigation in southern Provence, notably around Orange. A power station, comparable in its potential output with that at Génissiat, is to be built at Bollène and a canal is to by-pass the Robinet de Donzère to the east, where the gradient of the river is particularly steep and the channel difficult to navigate on account of its great depth and sudden bends. A series of locks, each 295 feet long, 40 feet wide and large enough to take barges of 1000 tons, will allow for a difference in level of 85 feet in a distance of 18 miles. Lyon is to be circumvented by a canal $6\frac{1}{2}$ miles long, with four locks. The barrages at Sault-Brenaz, Génissiat and Seyssel, in the Jura section of the Rhône, will eventually be by-passed by another navigation canal 28 miles long, with nine navigation locks and an elevator.[1] This canal is part of an international scheme to extend the navigation of the Rhône as far as Geneva, with an eventual link with the Rhine via the Aar and Lausanne. The regulation of the French Rhône is to be completed in twenty years and, apart from the power stations already discussed, others are projected below Lyon at Logis Neuf (Valence), Montélimar, Roquemaure, Avignon and Vallabregnes; a striking parallel with the regulation of the Tennessee with its series of dams and power stations, all of which, below the Norris dam at Knoxville, are provided with locks to facilitate navigation.

The Vosges and the Alsatian Rhine rift valley. Like the Rhône, the upper Rhine is suitable for damming by barrages of considerable width but of no great height. Downstream from Basle the regulation was carried out in the nineteenth century, but the regime remains semi-alpine and navigation upstream against the strong current is hazardous, especially at low water in late summer. The tributaries from the Vosges with their pluvial regime serve as compensators, but join the Rhine below Strasbourg. A few of these streams are utilized for the production of electricity in their highland valleys, Lac Blanc and Lac Noir serving as reservoirs. The chief pre-war plant was however that completed at Kembs in 1933, where Jurassic limestone rocks form rapids in the bed of the river at Istein to provide a fall of 50 feet. Power from this station is used to operate the locks on the Grand Canal d'Alsace

[1] P. George, 'Géographie de l'énergie,' p. 257.

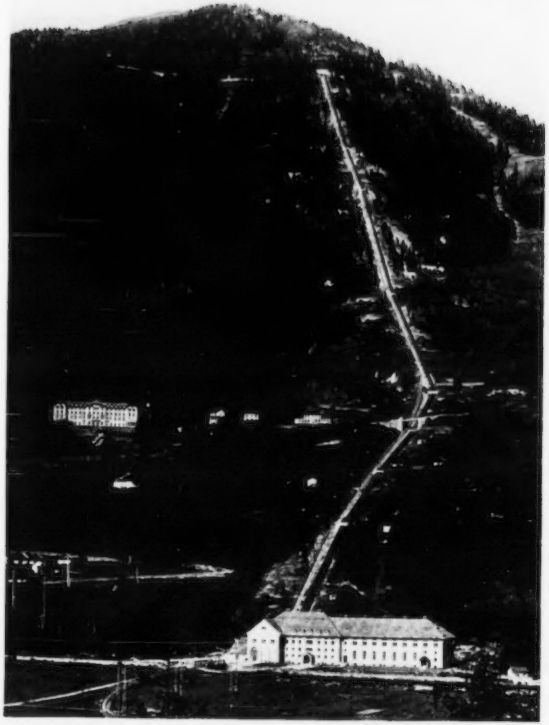
Phot. The Times

1. The Castillon dam on the Verdon, Provence

2. The gorge of the Isère (A–A shows the crest of the proposed dam)

Phot. Brügger Meiringen

3. The Grimsel reservoir (A–A shows the projected high-level dam)



Phot. Swiss Federal Rlys.

4. The Ritom station in the Val Maggia (Ticino)

which by-pass the rapids, and current is transmitted to the industrial towns of Alsace, such as Mulhouse and Colmar. Under the Monnet Plan for 1946–51, further barrages are planned below this point. That at Ottmarsheim is now under construction and others are projected at six sites between Ottmarsheim and Strasbourg.[1] The need to regulate the flow of the Rhine in its rift valley section was emphasized during the abnormal floods of December 1947, when the flow was so exceptional (six times the average for the time of year) that the power station at Kembs was temporarily put out of action; a year later the flow was scarcely half of the fifty year mean. The maximum flow usually occurs at the time of greatest snow melt in spring and early summer. The new station at Ottmarsheim is to produce an average of 840 million kWh. per annum, half the capacity of the Donzère–Mondragon site and the Génissiat station, but it will rank among the first three post-war installations in France. Most of the 127 new stations listed under the Monnet Plan are small, only thirty being designed to produce an average of 140 million kWh. per annum (see map).

The Pyrenees. Here, with a relief comparable in order with that of the Alps, the development of hydro-electric power has been spectacular and costly. Recent developments emphasize the advantage of steep gradients down which water may be led in concrete lined tunnels rather than open cuts, to restrict evaporation. At the new station at Luchon in the upper Pique valley, a head-stream of the Garonne, the penstock falls 3600 feet to the turbo-generators. Such advantageous conditions are found mainly in the central Pyrenees, where the slopes are steep towards the upper Garonne and the Ariège valleys and where winter snowfall is heavy, notably on the massifs of Maladetta and Gavarnie. At the Atlantic end of the Pyrenees conditions are also favourable, but only in these two regions does the mean total and seasonal precipitation maintain a regular flow of water. The rate of snow melt is highest in June and the flow is then at its maximum. The eastern Pyrenees, like the southern French Alps, suffer from Mediterranean summer drought; streams run low and the ice fields of the High Pyrenees are very restricted, compared with the High Alps. In consequence most of the sites which were utilized between the wars were below the Cirque de Gavarnie, and along the Adour, Garonne and Ariège valleys, where breaks of slope occur along the stream profile in valleys characterized by high gradients. These sites had also the advantage of strategic remoteness from the eastern frontier of France, an important consideration in developing heavy industry at Pamiers and Tarascon in the upper Ariège valley. Here electric arc furnaces were erected between the wars for the production of alloy and crucible steel.

The Massif Central. This region, which forms the hydrographic core of France, did not attract attention as a source of hydro-electric power until the late 1920's because of its relatively low relief, averaging under half that of the Pre-Alps and the outer Pyrenean ranges. Exposed to Atlantic moisture-bearing air currents, the western slope has a well-distributed precipitation with an autumn and a winter maximum, and a heavy snowfall on the High

[1] P. George, 'Géographie de l'énergie,' pp. 157–8.

Auvergne and "la Montagne." Impervious rocks predominate and, with a mean annual precipitation of well over 40 inches, the run-off is on the average 45 per cent. In the Truyère gorge, south of the Cantal massif, where the drainage is markedly rejuvenated so that gradients are almost alpine, the run-off increases however to 75 per cent. Since the streams are fed by winter and spring snow melt in their highest reaches, their regime is of a combined pluvial and nival type, with two maxima and minima and a relatively regular flow.[1] Nevertheless the construction of great barrages is necessary to regulate the flow and concentrate the fall at a particular site. Topographically, the upper Dordogne and the Truyère lend themselves to the construction of the apron type of dam, since the V-shaped gorges at Marèges and Sarrans favour the high barrage, impounding the maximum volume of water for the expenditure of concrete. Scenically, too, these sites recall that of the Norris dam on the Tennessee.

Several sites on the western slope of the Auvergne were chosen, and some of the schemes completed before the outbreak of war in 1939. These were the Éguzon dam on the Creuse (in 1926), the Marèges dam on the Dordogne (1935) and the Sarrans dam on the Truyère (1935). Below Sarrans, which has a capacity of 27,750 kW., there is a subsidiary underground station at Brommat, reached by tunnels fed from above the Sarrans barrage. Under the *Eytherma* project several additional installations are planned in the Dordogne valley, building having been in progress since 1942. The largest potential site lies near the head of the valley at Chavanon, with an output double that of Génissiat. Other large stations and barrages have been completed at l'Aigle (1945) and those at Bort and Chastang are to be finished by 1954.[2] It is hoped that the Massif Central will then provide more than a quarter of the hydro-electric power of France. Most of the current at present generated supplies the Paris–Orléans–Bordeaux railway and local industries have not yet been stimulated as in the Alps and Pyrenees.

Future projects

The development of hydro-electric power has so far been examined in relation to existing installations or those nearing completion; certain projects in the Massif Central of France and the western Alps are on a scale without a parallel in the Old World and, if carried out, would go far to meet the demand for power in western Europe in the near future. Supplies of power for transport and industry will be derived from new sources, dependent upon the completion of such projects as *Enytrac* for the southern Massif Central and *Emalp* for the western Alps. The boldness and imagination which have inspired these projects must invoke the practical interest of the whole of western Europe, since their economic use will be of an international order and will require the cooperation of all the countries which stand to benefit from their completion. An important step towards this concerted economic development has now been taken through the Marshall plan; and a special section of the Organization for European Economic Cooperation deals with the supply of electricity. The eventual aim is a grid system for western Europe, into

[1] E. de Martonne, 'Géographie Physique,' tome I, p. 477.
[2] P. George, 'Géographie de l'énergie,' pp. 255–6.

which current will be fed from such power stations as those to be built under the *Eytherma*, *Enytrac* and *Emalp* projects.

Table 2

A. Principal hydro-electric stations in France

	River	*Altitude, feet*	*Height of Barrage, feet*	*Potential (millions of kWh. per annum)*
Existing stations				
Bort	Dordogne	1626	330	264
Sarrans	Truyère	1938	315	122
Chambon ..	Romanche	3120	274	74
L'Aigle	Dordogne	1026	270	44
Marèges ..	Dordogne	1251	270	16
Génissiat ..	Rhône	990	309	10
Éguzon	Creuse	609	177	2·5
Under construction				
Tignes	Isère	5265	390	272
Projected				
Val d'Isère ..	Isère	6900	1689	20,400
St. Chély ..	Truyère	3346	390	12,720
Langogne ..	Allier	3346	486	11,910

B. Principal hydro-electric stations in Switzerland

	Altitude, (feet)	*Height of Barrage, (feet)*	*Capacity of Reservoir (millions of cubic feet)*	*Potential (millions of kWh. per annum)*
Existing stations				
Dixence	7349	295	176	200
Grimsel	6266	374	353	260
Under construction				
Dixence	7776	869	1518	2000
Projected				
Urseren	5348	656	4237	2820
Super-Urseren ..	6365	1689[1]	32,136	29,200
Super-Dixence ..	8596		7769	1100
Super-Grimsel ..	7546		7416	8000
Entrèves ..	5906		8475	6600

(Data supplied by Vincent frères, Neuilly-sur-Seine)

The Enytrac scheme (*Southern Auvergne and Cévennes*). Two sites are involved under this scheme, one at St. Chély d'Apcher in the upper Truyère

[1] The uniform height arises from their relation to the Val d'Isère reservoir.

valley and the other at Langogne, on the upper Allier. The reservoirs behind the barrages will be filled mainly by gravity flow from the adjacent volcanic uplands of Aubrac, Margeride and Velay. As they are near the water-parting between the Atlantic and Mediterranean drainage, it will be comparatively easy to divert surplus water from the reservoirs to the Rhône, via the Ardèche,

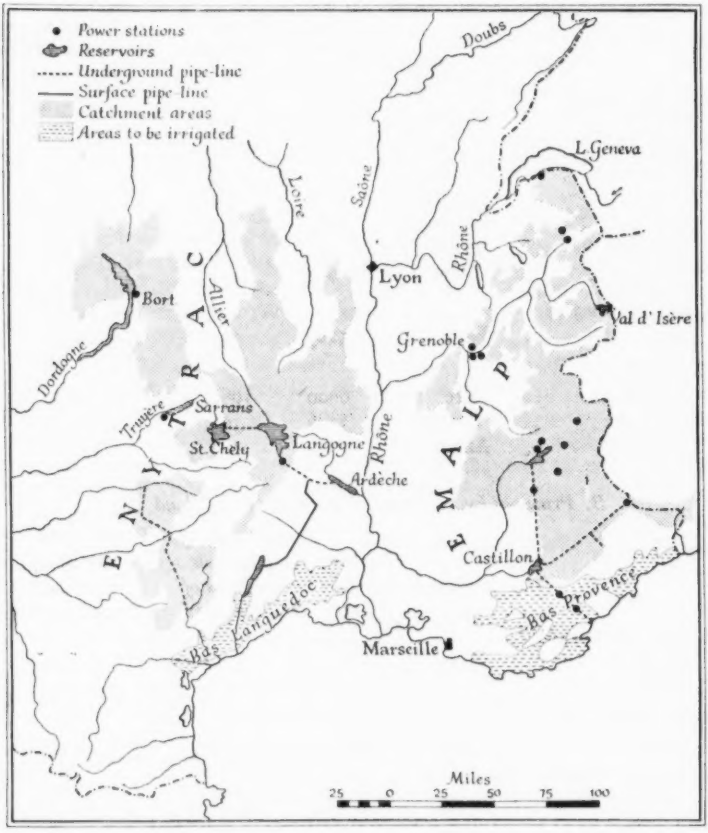


Fig. 1. The Enytrac and Emalp schemes

and also to Bas Languedoc for irrigation. This development of hydro-electric sites for irrigation, though employed in western America, Egypt and India, and envisaged in the Snowy River project in Australia, is new in western Europe. A feature, which the *Enytrac* scheme shares with *Emalp*, is the production of such a surplus of power that a market must be sought outside France; it is intended to transmit direct current at low tension throughout western Europe. The completion of such a grid, linking the power stations

of France with those of Britain and western Norway, would involve the construction of undersea cables. Such a connection has long been in existence between Sweden and Denmark and, if such an engineering feat can be extended, the circuit of North-West Europe with a link between Scotland and Norway could be completed. The practical advantages of such a system are of course offset by political and strategic considerations.

The Emalp scheme (*western Alps*). In this project the emphasis is to be on the high level site of Val d'Isère, below the Col d'Iseran, near the Franco–Italian frontier (Plate 2). The upper valley of the Isère is characterized by broad, flat-floored basins over 6000 feet above sea-level, alternating with great U-shaped defiles cut by the Isère valley ice transverse to the Graian Alps and the Vanoise massif. These topographical features lend themselves to the construction of high barrages, impounding a vast volume of water, to form basins of accumulation which can be drawn on at all times of the year. Since the catchment area is limited to slopes over 6500 feet, a special problem is the need to maintain a constant level during the period of winter minimum flow. It is planned to draw water from a large area of the western Alps above the level of the reservoir, including the Vanoise, Pelvoux and Belledonne massifs in France, the Graian and Mt. Blanc massifs on the Franco–Italian border, and the Pennine Alps, the Bernese Oberland and the Aar and St. Gotthard massifs in Switzerland. Tunnels will reduce the risk of ice formation and also check evaporation. To maintain a minimum level of 6500 feet for gravity flow to the reservoir, it will be necessary to use syphons and aqueducts where passes and cols need to be traversed below this elevation, as at the Grimsel, St. Gotthard, Simplon, Mt. Cenis and the Col de Lautaret. Tunnels will also have to be constructed under the glaciers of the Rhône, Aletsch, Mer de Glace and the Dixence. Whereas the winter minimum flow of the Isère is at present only 20 per cent. of the mean, the flow is to be so regulated that it never falls below 38 per cent. Not only will its unique elevation enable the reservoir to supply, without additional pumping, stations in France, Switzerland and Italy, but the surplus water will swell the volume of such rivers as the Isère and Rhône when at their minimum. This increase will be especially important to the Rhône valley power stations, not only at Martigny and at Chancy Pougny, below lake Geneva, but also at Seyssel and Génissiat. It is estimated that the increase in the flow of the Rhône at its minimum will be between 30 and 40 per cent.

In summer, when the Val d'Isère reservoir reaches its maximum level, water will be stored to equalize the flow to the power stations at all seasons. During this season, it is expected that snow melt will supply the stations without additional supplies from the reservoir. The capacity of the reservoir is to be 173,042 million cubic feet, impounded behind a barrage 1689 feet high (more than twice the height of the Hoover dam in Arizona); a subsidiary dam to the west of the Val d'Isère will impound a small reservoir with a capacity of 4220 million cubic feet. Below the main barrage, a minor one is to fill in the gorge below Tignes. The foundations of this dam were laid in 1949 and the village of Tignes is to be moved to a new site, by the shore of the Lac des Tignes. From this point a new road will lead past the Val d'Isère reservoir

to join the *route des Alpes* over the Col d'Iseran at 9000 feet. A new engineering "town" has been laid out at Tignes and much casual foreign labour is being employed on the project. Bourg St. Maurice, at the railhead,

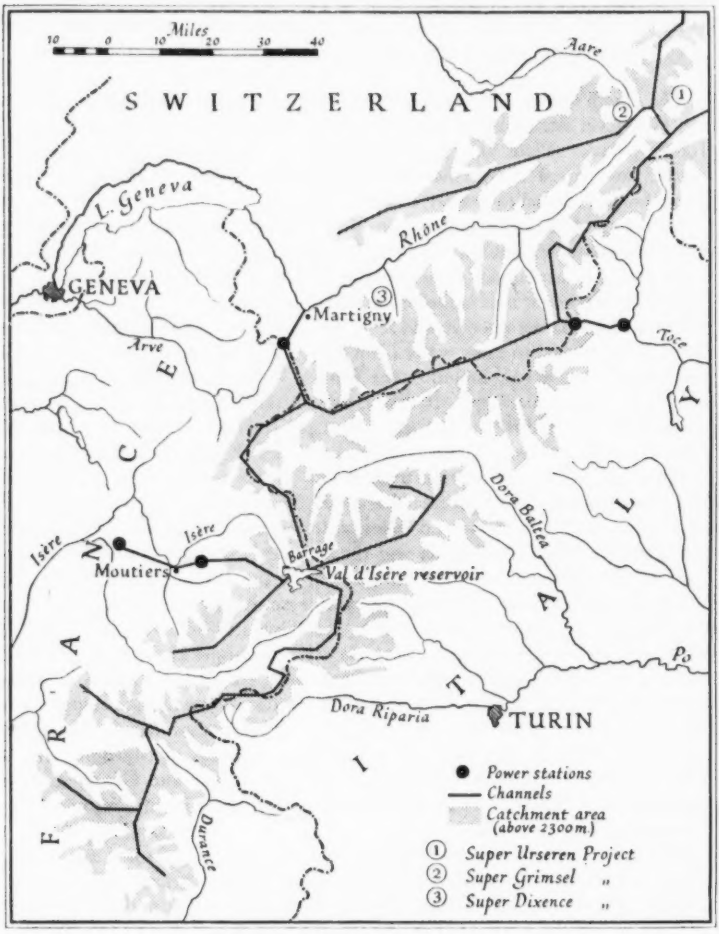


Fig. 2. The Val d'Isère project

is the supply base, with plant recently completed for the production of concrete, etc. It is estimated that the barrages will take six years to complete and new American methods of tunnel blasting, using an oxygen flame at 2000° C., will greatly facilitate the construction of the main artery and its subsidiaries. The Mt. Cenis tunnel (40,350 feet long) took fourteen years to

build and was completed in 1857, and the Lötschberg (47,570 feet), opened in 1906, took five years. A rate of advance of 16 feet an hour may now be possible.[1]

The *Emalp* project involves the construction of a number of new power stations in valleys well below the Val d'Isère reservoir. There are to be three main installations, one on the Swiss Rhône below Martigny, another in the Toce valley, and a third series in the Isère and Arc valleys. The Swiss station will utilize the steep drop over the rock bastion at Martigny, between the Trient gorge and the Rhône valley.[2] In Italy, two power stations are envisaged, at Entrèves and on the Toce at Domodossola. In France, the main station is to be at Moutiers, on the Isère, with a subsidiary plant at Aiguebelle, on the Arc. With a potential capacity of 31,600,000 kWh. (compared with 6,030,000 kWh. for T.V.A. in 1942), it is estimated that the scheme will pay for itself in about six years. The French stations would have the greatest potential (20,400,000 kWh.) and an immediate market for the current may be found in the French aluminium industry. France now exports bauxite from the Department of Var to Switzerland, where there are plants on the upper Rhône at Brigue and Visp, and the completion of these new power installations may well stimulate this and other "alpine" industries, mainly of an electro-metallurgical and electro-chemical nature.

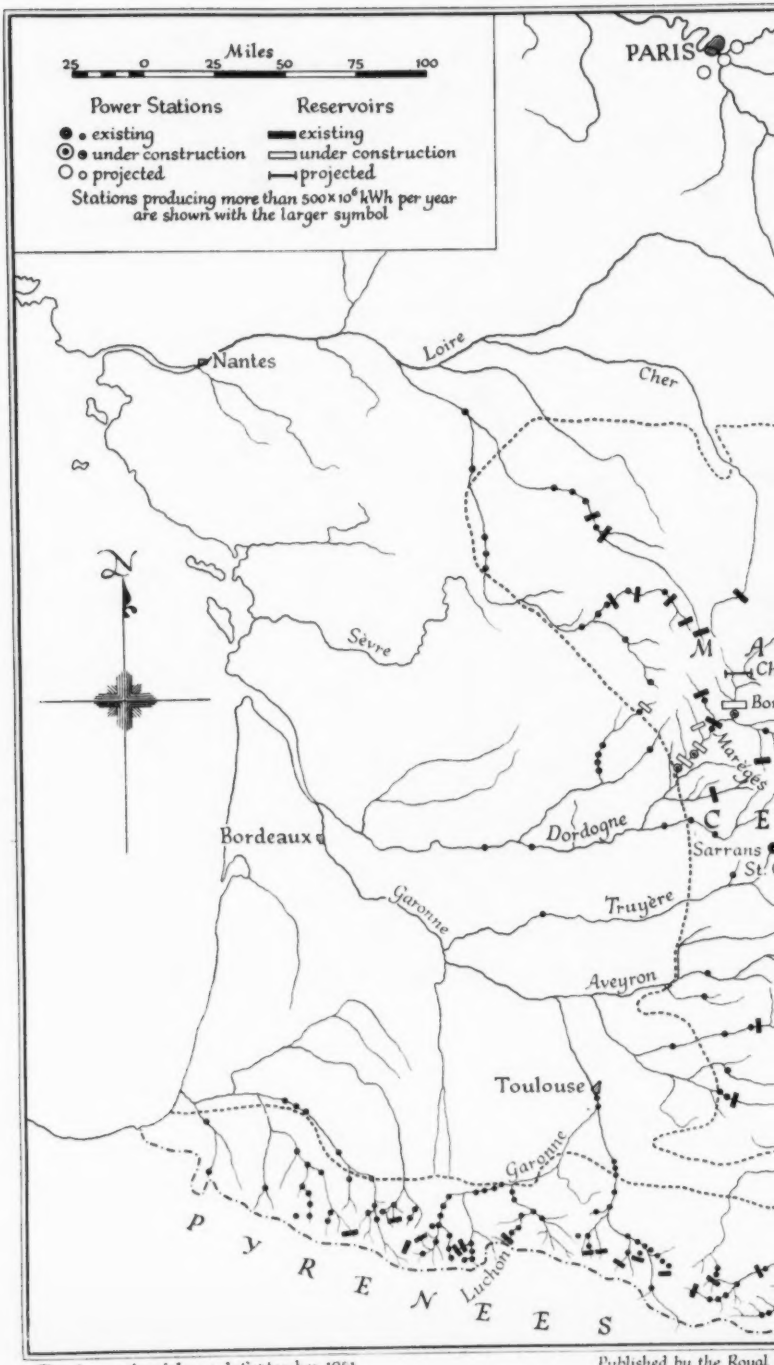
The *Emalp* project will have repercussions throughout the western Alps, in Switzerland and Italy as well as France. The Swiss contribution to the scheme, apart from the construction of the power station below Martigny, may eventually involve raising the level and enlarging the capacity of the existing Grimsel and Dixence reservoirs to supply the Val d'Isère. A third project is the Super-Urseren reservoir in the upper Reuss valley above Andermatt; local opposition is strong, but the flat-floored basin of the Reuss would provide an ideal site for a reservoir and the head of the Schöllenen gorge at the Devil's Bridge lends itself to the construction of a barrage. It is also planned to enlarge the power station at Amsteg which supplies current to the St. Gotthard line on the ascent from Lucerne, and the station at Ritom in the Ticino valley on the Italian slope leading to Bellinzona.

The Dixence and Grimsel projects present great problems. The catchment areas which would supply these relatively inaccessible reservoirs are small, as a result of their great elevation, and the stations dependent on them would have a relatively low potential capacity. The Super-Dixence scheme would, for example, involve a barrage 853 feet high to produce 2000 kW. at an altitude of 7860 feet and in summer auxiliary pumping would be needed to maintain the regular flow of water which is essential to the project. In spite of these drawbacks, work is already in progress on the first stage at the Dixence site. Similarly, the Super-Grimsel project involves the raising of the level of the fairly recently completed Grimsel reservoir and the building of additional power stations. Between the wars a basin $3\frac{1}{2}$ miles along was created above the Grimsel lakes, 6280 feet above sea-level (Plate 3). This reservoir, impounded behind the Spitallamm and Seeuferegg barrages, is fed by

[1] Vincent frères: 'Aménagement hydro-électrique des Alpes Occidentales: Projet franco-Italo-Suisse dit Val d'Isère,' 1948.

[2] Cotton: 'Climatic Accidents,' p. 233.

FRANCE : HYDRO-ELECTRIC



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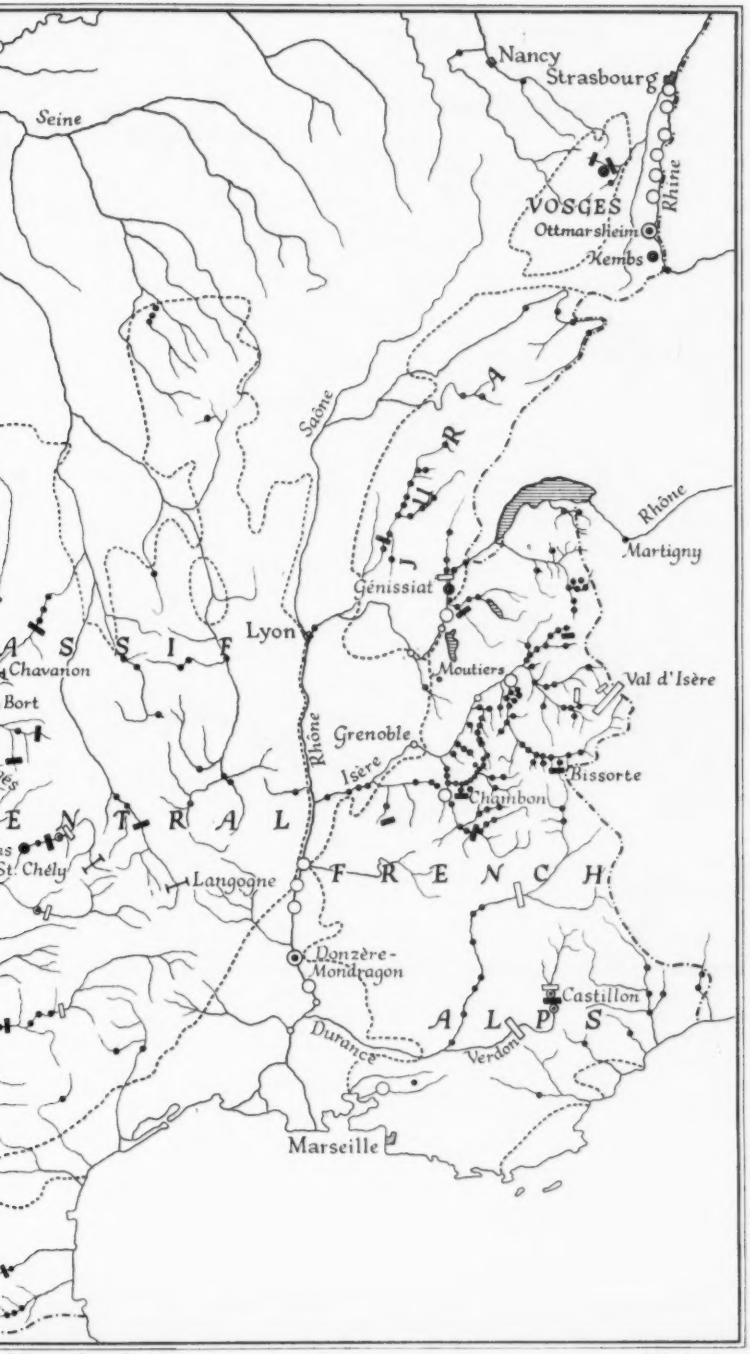

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melt-water from the Unteraar and Oberaar glaciers and has a capacity of 353 million cubic feet. The supply is so regular that in mid-winter the minimum flow falls to only 565 cubic feet per second below the mean of 7996 cubic feet per second. Water is led by a tunnel $3^1/_4$ miles long to the Gelmersee at 4260 feet, the level of which is raised by a dam 115 feet high. From this point there is a drop of 1789 feet to the *riegel*, or rock bar, where the Handeck power station is situated below the falls of the Aar river. During the war, the penstocks were extended to a new station at Innertkirchen, where the Kirchet *riegel* is cut by the deep and narrow post-glacial gorge of the Aar and provides an excellent site.[1]

It is clear that the new projects just described are on a scale never before envisaged in Europe. The table which concludes this paper shows the relative sizes of the new hydro-electric power installations projected in western Europe and the principal installations existing in other parts of the world.

Table 3

	Height of dam, (feet)	*Average fall to turbine, (feet)*	*Installed, or potential, capacity (thousands kW.)*	*Irrigated area (millions of acres)*
Hoover (Boulder dam), U.S.A.	722	490	1318	4·9
Grand Coulée, U.S.A.	524	334	1822	1·1
Dnieprostroi, U.S.S.R.	131	118	700	nil
Langogne (*projected*)	486	2588	2253	0·4
Val d'Isère (*projected*)	1689	5709	2780	nil

(From material supplied by Vincent frères)

The writer wishes to acknowledge a grant received from the Central Research Fund of London University for field work carried out in the Alps, the Rhône valley and the Massif Central during the summer vacations of 1948 and 1949. This paper was written in 1950.

[1] Cotton: 'Climatic accidents,' p. 255.

ACCIDENTS AND INTERRUPTIONS IN THE CYCLE OF MARINE EROSION

C. A. COTTON

In New Zealand the rate of retrogradation of the shore is very rapid on the cliffed mountainous coasts in the vicinity of Wellington, largely because of a steep offshore profile and restricted supply of beach-making waste.[1] The scour of strong tidal currents in the narrows of Cook Strait prevents the accumulation of locally derived waste as a shelf and little sand is brought in from outside sources by transport alongshore. In general it may be said that only a "hungry" ocean gains "advantage on the kingdom of the shore." Marine erosion is, on the other hand, unquestionably slowed down by an abundant supply of sand which may be derived from some rather distant source; such an influx comes generally from a large river entering the sea fully loaded, as do many which debouch on the New Zealand coasts. River-supplied sand and silt commonly build the continental shelf, up and out, thus reducing the steepness of the submarine slope immediately bordering the land until the waves break offshore and expend their energy there, driving sand beachwards, instead of breaking at the shoreline and undercutting the cliffs.

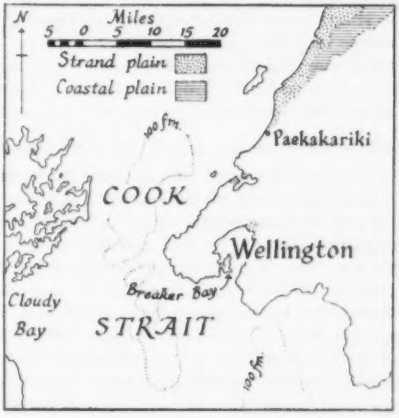


Fig. 1. Cook Strait

Temporary beaches may be thrown up however on all exposed shores, where they protect cliffs from erosion, though the waves resume their attack intermittently when from time to time, during storms, the beaches are destroyed. Such intermittent beach building accompanies most cliff cutting, even where the supply of rock debris is limited to that provided by the cliff itself. After the historic upheaval of the land at Breaker Bay, near Wellington, in 1855, a storm beach of this kind became a raised beach which remained separated from the wave-cut cliff behind by a low-lying swampy strip of land. Photographic illustrations of this fine specimen of a raised beach-ridge have been published,[2] but the feature itself has been destroyed by road makers and is no longer available for inspection.

[1] C. A. Cotton, "Sea-cliffs of Banks Peninsula and Wellington," *N.Z. Geographer* (in press).

[2] C. A. Cotton, "For how long will Wellington escape destruction by earthquake?" *N.Z. Jour. Sci. Tech.* 3 (1921) 220–31 (Fig. 1); and 'Geomorphology,' 5th ed., Christchurch and New York, 1949 (Figs. 413, 444).

Progradation

Should the supply of waste moving alongshore from a distant source become greater, it may put an end to coastal erosion, for protective beach deposits of a more permanent nature may accumulate. This commonly follows the rectification of an initially embayed shoreline. The continuous beach provides a transport route for sand and even gravel and, if such materials are constantly available in sufficient quantity from a source to windward, progradation will thereafter go on uninterruptedly. Beach ridges will be added to the shore one after another to build a strand plain, which will retain a pattern of ridges if it is of gravel but which will become a dune-covered foreland if the prograding debris is sand, as is the case on most of the extensive and geographically important forelands or strand plains. These are often referred to by geographers as "coastal" plains, though strictly excluded from that category by the geological definition of a coastal plain which implies emergence as a result of the withdrawal of the sea to a lower level.

Alluvial fans of gravel derived from the hinterland may partly cover this foreland, perhaps becoming confluent to form an alluvial plain which will mask and partly bury the ancient sea cliffs at the rear, and these will meanwhile fade in sharpness as a result of subaerial grading; the foreland and alluvial plain may merge into the deltas of the larger rivers. Thus, especially on a mountainous coast, progradation is often in part marine but in greater part alluvial. The coast formed by the broad river-built Canterbury Plains of New Zealand which border the Southern Alps provides an example.

The interruption of a marine cycle by progradation

The former coastal outline of the hinterland will thus retire inland to become a landscape scarp at the rear of a flat, low-lying and almost featureless coast fringed by a continuous sand beach and foreland. Features due to marine retrogradation, though blurred and fading, may still be recognizable to distinguish such a scarp from scarps produced by selective subaerial erosion or a tectonic process. In such a case the cycle of retrogradation of the ancient coast has been terminated by some accident of progradation after reaching a sub-mature or mature stage (Fig. 2, *D*). Such a cutting short of the cycle of marine retrogradation introduces a "complication" [1] which may conveniently be termed a progradational "accident," even though it may develop inevitably under specified conditions. It may be remarked that the treatment of climatic and volcanic accidents as "complications" of the marine cycle seems scarcely worth while.

The transfer inland of a former shore when brought about not by progradation but by a retreat of the sea to a relatively lower level (Fig. 2, *B*) has been recognized by Davis [2] as a true "interruption", for it introduces a new marine cycle; perhaps one of retrogradation if the subaqueous profile of stage *B* has been steep enough. This is the origin of the cliff line (2) in Figure 2, *C*, which borders the truncated margin of the coastal plain of stage *B*. In the diagram it is shown bordered by a strand plain, the progradational growth of which is an "accident" closing the development cycle of cliff line (2).

The Paekakariki coast

Part of the west coast of the Wellington district, extending northward along the wide northern part of Cook Strait (Fig. 1), is now bordered by a

[1] W. M. Davis, "Complications of the geographical cycle," *Rep. VIII Internat. Geog. Cong.* (1905) 159.

[2] *Loc. cit.*

continuous sand-built and dune-covered foreland due to recent progradation (Plate 1). A bench at the rear of the northern part is interpreted as an extensive remnant of a coastal plain [1] (compare Fig. 2, *C*) but at the southern end of the foreland this is not present. Both the northern and southern parts afford examples of cliffed or formerly cliffed shorelines that have become inland scarps.[2]

The foreland is extending progressively southward, so that the dune-covered plain so formed borders freshly cut cliffs and itself narrows to a thin edge at Paekakariki (Plate 1). South of Paekakariki the cliffing of a mountainous shore is still in progress (compare Fig. 2, *E*). Here the deformed greywacke strata of the mountainous axis of the land are exposed to wave attack and a mature line of cliffs, up to nearly 1000 feet in height, faces the sea. The cliff line continues far northward at the rear of the strand plain, truncating gravel fans built out from the hinterland (Plate 1 and Fig. 2, *E*) in a manner which indicates that the

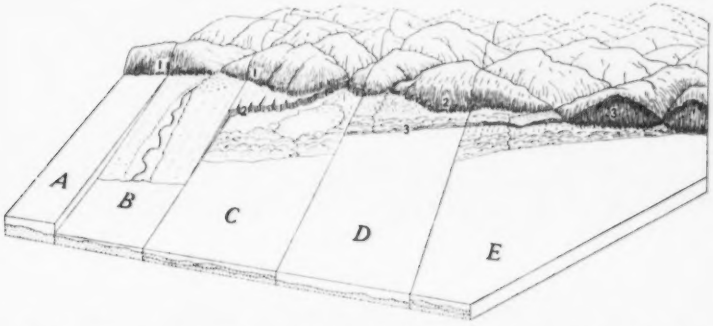


Fig. 2. Interruptions and accidents in the cycle of marine retrogradation [3]

growth of the foreland has not been a continuous process but has been interrupted by retrograding oscillations. The cliffs that truncate the fans correspond to the cliffs of line (3) in Figure 2 which freshen (or rejuvenate) the cliffs of line (2) and make the cliffs at Paekakariki recognizably "two-storied."

North Auckland coasts

The effects of a very extensive progradation on the outline of a drowned coast are seen on the western (strongly contrasted with the eastern) coast of the long peninsula of North Auckland (Fig. 3). The peninsula as a whole is one of the most stable parts of New Zealand, being at present quite non-seismic [4];

[1] R. L. Oliver, "The Otaki sandstone and its geological history," *N.Z. Geol. Memoirs*, 7 (1948) 35.

[2] C. A. Cotton, "The outline of New Zealand," *Geog. Rev.* 6 (1918) 320–40 (p. 330); "The geomorphology of the coastal district of south-western Wellington," *Trans. N.Z. Inst.* 50 (1918) 218.

[3] The cycle of marine retrogradation (A) terminated by interruption (B); and a progradational accident (C, D, E). The strips D and E illustrate oscillation between retrogradation and progradation. Successively younger lines of cliff: 1, 2, 3. (Upheaval of land between stages A and B is shown conventionally as lowering of sea-level.)

[4] B. Gutenberg and C. F. Richter, 'Seismicity of the Earth,' Princeton Univ. Press, 1949 (Fig. 14, p. 46).

recent differential movement is therefore improbable and an apparently uniform drowning of the land may with confidence be attributed to the post-glacial eustatic rise of the ocean level.

Casual inspection of a map might suggest that the striking contrast between the long straight western coast, in most parts beach-fringed, and the intricately embayed eastern shoreline, with only pocket beaches and a few sandspits, is due to the difference of aspect in relation to the prevailing winds. The western coast does indeed face the prevailing wind and is continuously pounded by surf, whereas the eastern is a leeward and sheltered coast. To a large extent the bedrock skeleton of the land has however escaped strong retrogradation on both coasts. But while the peninsula is exposed to weak wave attack throughout much of its sheltered eastern shore, the bedrock on the western side is for long stretches

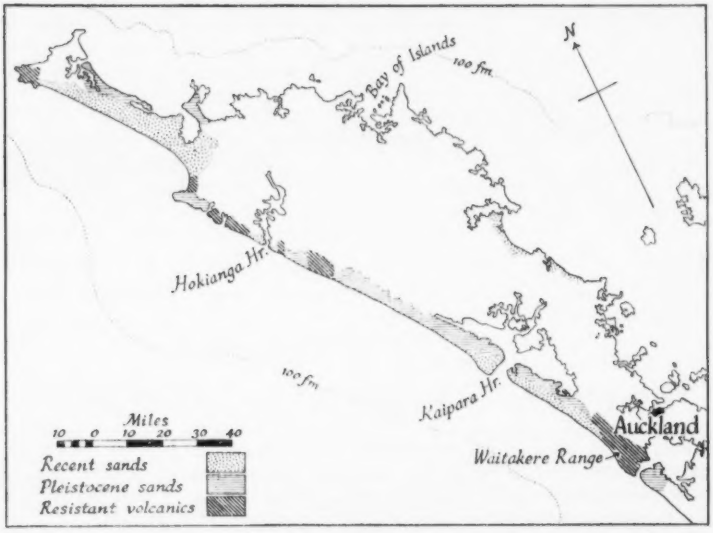


Fig. 3. The North Auckland peninsula (from N.Z. geological map, 1947)

shielded from all waves by very extensive accumulations of progradation. Portions of the bedrock, consisting of Tertiary volcanics, which do reach the western shore and formerly projected farther seaward, are however strongly cliffed and trimmed back to the general line. One of these is the mass of resistant lavas and breccias forming the Waitakere range near the Auckland isthmus at the south end of the peninsula (Plate 2).[1]

The residual beach material derived locally from the erosion of volcanic formations is a black magnetite sand, but the bulk of the sand which has been available for the extensive progradation of the west coast is quartz and felspar from a more distant source and travels alongshore from the south. The rhyolitic volcanic ash which supplies these minerals has been furnished progressively

[1] The cliffs, now two-storied, have been freshened by late Flandrian marine erosion; cliffs of an earlier retrogradation had apparently been graded sub-aerially during a withdrawal of the sea.

Phot. N.Z. Ministry of Works

1. The Paekakariki coast

Phot. Whites Aviation Ltd.

2. Cliffs of the Waitakere range

3. The drowned valleys of Whangaroa Harbour from the heads

Photo. Whites Aviation Ltd.

4. Entrance to Tauranga Harbour, Bay of Plenty

over a very long period (probably throughout the Pleistocene and perhaps earlier) by explosive eruptions in the central volcanic district of the island. Reaching the western coast mainly by way of the Waikato river, a considerable part has been transported north-westward by current and wave action for distances up to 200 miles. Sedimentation, depending no doubt on the material thus supplied, has built out the marginal shelf to a width of 30 to 40 miles, with a steep outer slope descending to ocean depths. Meanwhile beach sand sorted from the ash has accumulated in dune-covered coastal forelands at former and higher levels of the sea, as well as at its present level. A marginal belt (Fig. 3) up to 8 miles wide consists of lightly consolidated sands in a complex of Pleistocene (and perhaps also pre-Pleistocene) marine forelands which have been built out in defiance of the Flandrian and interglacial submergences. This is illustrated in a generalized diagram (Fig. 4). Fringing a belt of young sandstones (*P*) is a still younger foreland (*F*) which is largely a complex of anchored

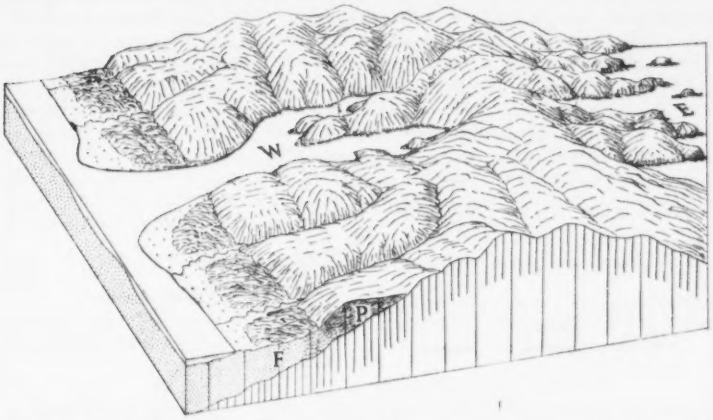


Fig. 4. Diagram to show the contrast between western and eastern coastal forms in North Auckland [1]

and wandering dunes. Rivers have cut outlets through the marginal sandstones from their inland valley systems in the hinterland bedrock when sea-level has been low (in Glacial times) and their drowned valleys are now the west coast bar-harbours (Fig. 4, *W*) such as Kaipara and Hokianga.

Much of the east coast (Fig. 4, *E*) is by contrast quite free from progradation, nor is it fringed by foreland deposits of earlier date. Apart from spits and bars of relatively small extent, developed in the postglacial cycle, which rectify parts of it to a submature outline, most of this coast is still quite young, with high cliffs and crenulate shorelines only on the headlands and islands. Most of it is also very intricately embayed (Plate 3) and there are many outlying islands. Even at the bay-heads there is little infilling except by tidal mudflats and mangrove swamps.

The peninsula is of complex geological structure, a mosaic of resistant and relatively weak rocks, and with the exception of a few peneplain remnants its

[1] (*W*) is a western bar-harbour embayment, (*E*) a Bay of Islands type of drowned eastern coast; (*P*) Pleistocene sandstone; (*F*) Flandrian and recent sand accumulations.

relief is mature, though varying in places from "feral" to subdued. The areas of hard rock naturally present the strongest relief, occasionally mountainous and in part surviving from a rather remote period of strong differential upheaval, but very largely due to selective erosion. The scenery of this coast varies with the land slopes and relief, which are controlled by the nature of the rocks; yet the map outline is very similar throughout, as is to be expected where the Flandrian transgression has drowned a well dissected land, and there has been as yet but little infilling of bays because of the small catchment areas of the rivers and their consequently small loads of detritus.

On the west coast, landward of the drowned gorges through the marginal belt of Pleistocene sandstone, there are very extensive ramifying drowned-valley systems in the dissected older terrain. These are indeed identical in

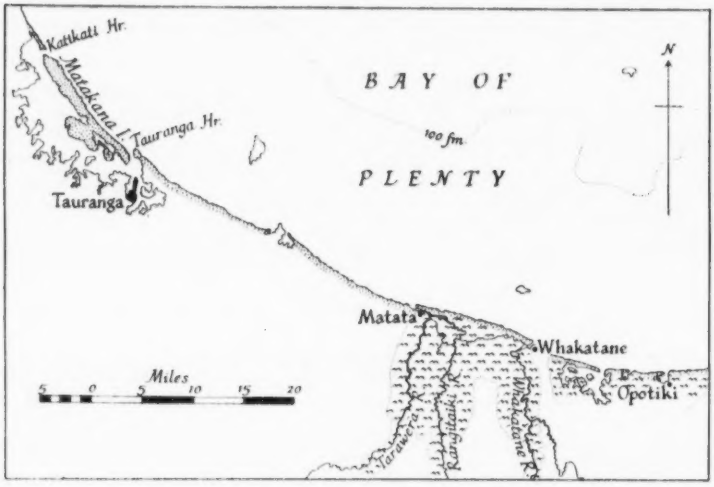


Fig. 5. Confluent deltas in the Bay of Plenty [1]

character with inland reaches of the east coast embayments, from which they are separated in places by low divides of no great width. Thus the submergence history of the two coasts is the same. The progradational belt of the west coast, with its straight, largely constructional shoreline, serves as a large scale example of the protection from wave attack which beaches and dune belts afford.

The Bay of Plenty coast

Another area in which progradation has supervened to interrupt, or perhaps here to forestall, a normal cycle of retrogradation on a drowned coast is seen in the Bay of Plenty, on the east coast of the North Island (Fig. 5). For a hundred miles the coast around the head of this bight is fringed by offshore bars and beach ridges of similar origin. Though these are like some which have been thought elsewhere to afford proof of coastal emergence, it is here unnecessary, and probably incorrect, to postulate a shallowing of the sea by a differential

[1] Outlines of delta plains from E. O. Macpherson in *N.Z. Jour. Sci. Tech.* 26B (1944) 67.

movement to account for the overloading of waves with sand which has led to the piling-up of an offshore bar. Though the hypothesis that there has been some recent upheaval need not be rejected as inherently improbable, for this is a volcanically active district, the plentiful supply of sand which is here driven landward and thrown up in the zone of breaking waves can be explained in another way. It is quite probably due to a local shallowing of the sea by showers of pumiceous rhyolitic ash from the great explosive eruptions in the central volcanic district of the North Island which is adjacent to this coast.[1]

The dissected margin of a plateau inclined towards the sea and composed mainly of a sheet of ignimbrite (welded tuff) has here been drowned, possibly by the Flandrian transgression. The barrier beach bordering it has, except for tidal "inlets," shut off from the sea the extensive branching embayments which form Katikati and Tauranga harbours with their connecting channel (Plate 4).[2]

Farther east other large embayments similarly enclosed have become alluvial plains, largely swampy until converted into agricultural land by drainage. The plains between Matata and Whakatane (Fig. 5), which occupy one of the largest of these basins, are formed by the coalescing deltas of three major rivers and the infilling of the bay has no doubt taken place very rapidly. In contrast with the North Auckland peninsula, and with the restricted (though mountain-girt) catchment area draining into the enclosure forming Tauranga and Katikati harbours, abundant waste has here been available; both greywacke gravel, from mountains undergoing dissection under heavy rainfall to the south-east, and also pumiceous debris, from an extensive volcanic plateau to the south and south-west which has been showered with ash at intervals and is drained by the Rangitaiki river.

[1] C. A. Cotton, 'Volcanoes as landscape forms,' Christchurch and London: Whitcombe and Tombs, 1944, p. 190.

[2] "The Mount" (Maunganui) in the middle distance is a volcanic island tied to the mainland by a spit-forming barrier beach which continues behind the inlet as a true off-shore bar (Matakana Island).

THE CHERANGANI ROAD IN KENYA

M. A. UNWIN-HEATHCOTE AND J. B. CARSON

IN THE FARTHEST corner of Kenya, bordering the Sudan and Uganda, lie the sandy wastes of Turkana. To the south, within fifty miles of Kitale township, lies the Cherangani range with such peaks as Kapsait, Kuserua and Kaisungur. For nearly a hundred miles a high narrow ridge of hills extends south-east of the Cherangani almost to the Equator, marching with the farming areas of the west and the native lands of the east. To the east the ridge falls nearly 4000 feet in an almost sheer escarpment; to the west it broadens into the open spaces of the Uasin Gishu plateau; the watershed lies in the Kerio native land unit. Scenically it provides some of the grandest views in Kenya and it is valuable for its forests of cedar, olive and *Podocarpus*. The escarpment shows some fine examples of faulting for the ridge is in fact one wall of the Rift, the opposite side, the Laikipia escarpment, lying some forty miles away.

It was through these forests that it was decided to make a road from the administrative area of Elgeyo–Marakwet, which straddles the watershed, to the

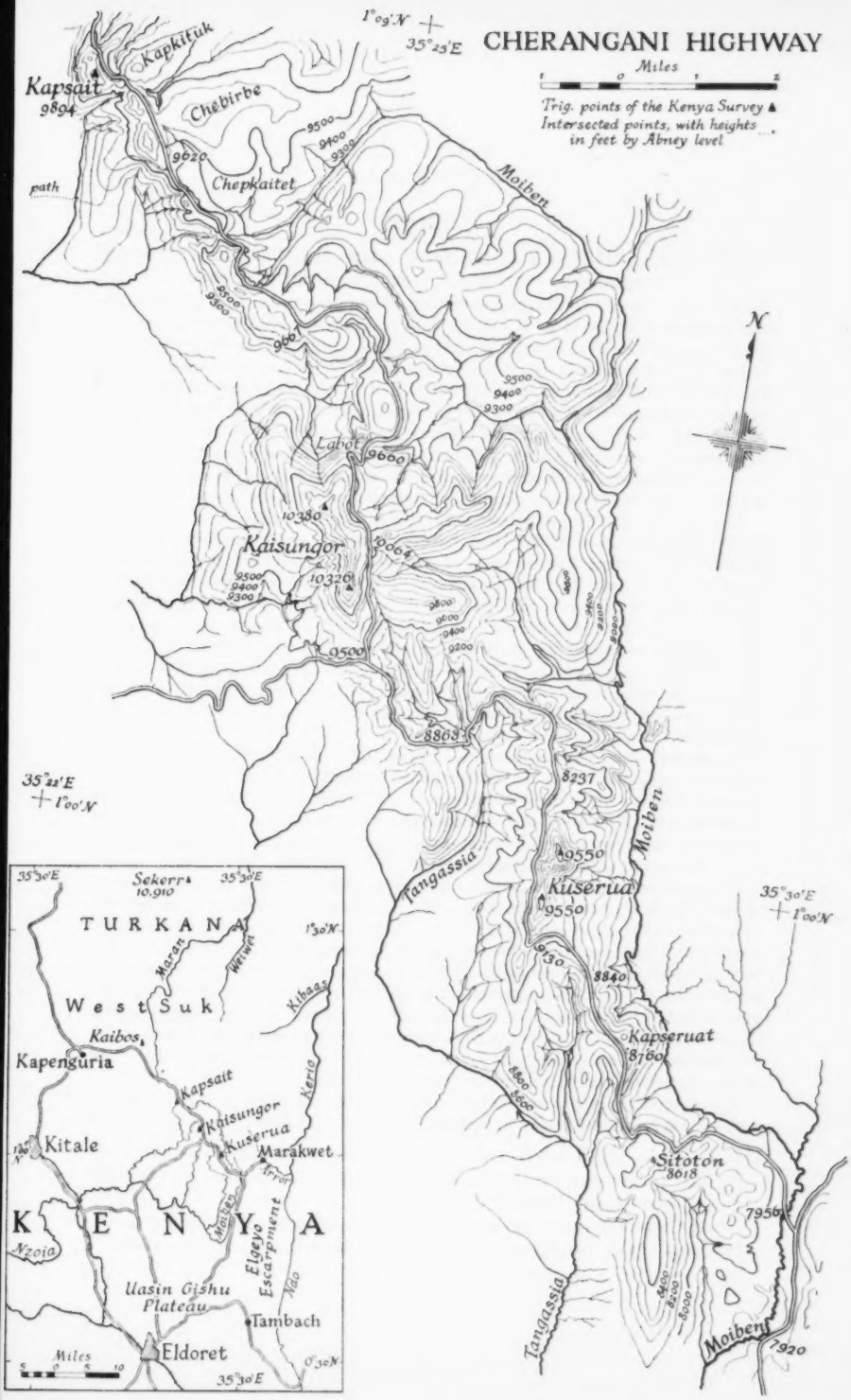
adjoining administrative area of West Suk in the Cherangani Hills. Starting at an altitude of 8000 feet, this would climb to 10,000 behind the mass of Kaisungur to meet a route from Kapenguria, the administrative centre of West Suk. All this area has hitherto been without roads and has only been walked over from time to time by a few government officers; previous surveys were sketchy indeed and, to judge from checks we made with existing maps, they seemed to have been largely guess-work. The map accompanying this paper is based on compass bearings and a wheel and compass traverse adjusted to stations of the Kenya Survey; heights are from aneroid readings controlled by a chain of boiling-point observations. Use was also made of a forest boundary survey published by the Kenya Survey Department.

Our first objective was to find a suitable crossing of the Moiben river (8000 feet), then to climb to Kuserua (9550), get round this obstacle, and find a suitable gradient downwards to join the existing track four miles from Labot. This involved another climb up to 10,000 feet. From Labot it was only eight miles to the base of the distinctive conical peak of Kapsait (9894). After a false start we got going through a thick forest of cedar and *Podocarpus*; other trees in this grand forest include the hard timber, *Pygeum Africanum*, and various olives such as *Olea chrysophylla* and *O. Hochsteterii*. Cutting the road itself (by hand with axes, hoes, picks and shovels) was necessarily hard work and reflected much credit on the local headmen and road foremen and their large gangs. From the Moiben river to Kuserua was mainly through thick forest but, by contrast, the next sixteen miles to Kapsait was largely through open country and the work of surveying and road making was much quicker. We had time to admire the fine view to the south over the plains of the Nzoia river, with Mount Elgon's blue mass rising to over 14,000 feet in the west. It is worthy of note that this mountain was first explored less than sixty years ago, at Christmas time, by that distinguished Gold Medallist of the Society, Joseph Thomson. The scenery from Kapsait to Kapenguria is even more wild. The Arror, Moiben and Embobut, which rise in these forests, flow in a south-easterly direction while the Maran and the Weiwei flow northwards into the plains of West Suk; other minor streams become mere trickles in the dry season.

The new road will link three of the semi-pastoral Nilo–Hamitic tribes of the Rift Valley Province; the Suk, administered from Kapenguria, and the Marakwet and Elgeyo, administered from Tambach. As with their neighbours the Nandi, their acquisition of stock is comparatively recent, within the last twenty years; long before the advent of the European they were honey hunters and elephant poachers in these forests. The game in this area includes leopard, giant forest hog, buffalo, bush buck and the rare bongo; the birds include the lovely blue-green louries with a red underwing and innumerable green parrots.

Besides providing a fine scenic way, the road will open up a hitherto untouched area, and it is to be hoped that some control will then be exercised over the ever increasing herds of native cattle which roam at will and have eaten out the available grazing which was once fine red-oat pasture grass. Better access should help the police to deal with stock theft and enable government officers to attend to the preservation of waters, forests and natural resources. It will facilitate the marketing of stock in return for trade goods, and the marketing of stock relieves the carrying capacity of the grazing, with a consequent increase in the prosperity of the inhabitants.

In planning the route we were much helped by the preliminary reconnaissance carried out by a former District Commissioner of the area, Mr. D. Storrs-Fox.


1°09'N + 35°23'E
CHERANGANI HIGHWAY
Miles
Trig. points of the Kenya Survey ▲
Intersected points, with heights in feet by Abney level
Kapsait 9894
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9620
Chepkaitet
path
Moiben
9500
9400
9300
9600
Labot
9600
10380
Kaisungor
9064
10326
8868
8237
35°22'E + 1°00'N
Tangassia
Moiben
9550
Kuserua
9550
9130
8840
Kapseruat
8760
8800
8600
35°30'E + 1°00'N
Sitoton
8018
7956
7920
Tangassia
Moiben
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TURKANA
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Maran
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West Suk
Kibaas
Kaibos
Kapenguria
Kapsait
Kerio
Kaisungor
Kuserua
Kitale
Marakwet
1°00'N
Turon
Weiwei
KENYA
Elgeyo Escarpment
Nzoia
Uasin Gishu Plateau
Tambach
Eldoret
Miles
0°30'N
35°30'E

REVIEWS

EUROPE

TOWN AND COUNTRY PLANNING 1943–1951 (Cmd. 8204). *London: H.M. Stationery Office*, 1951. $9\frac{1}{2} \times 6$ *inches;* viii + 215 *pages; maps.* 5*s*

This white paper is unusually interesting to the geographer and so smoothly and persuasively written as to make it easy and pleasant reading. It covers the whole period of existence of the Ministry of Town and Country Planning *per se*. Before 1943 planning functions in England and Wales had been exercised by the Ministry of Health and for a brief period by the short-lived Ministry of Works and Planning. Since the beginning of 1951 it has been merged in the Ministry of Local Government and Planning. Geographers have latterly played an appreciable part in the work of the Ministry and the white paper clearly shows the kind of problem to which they are endeavouring to make their contribution; the art of town and country planning is indeed applied geography.

In a democratically governed country, the greatest problem is perhaps to discover how much can effectively be done without an approach to dictatorship. Where the negative function of control is appropriate and predominant there have been administrative successes. Post-war England and Wales show on the whole a markedly smaller growth of landscape eyesores than in the years preceeding the war, though it must be pointed out that another control is automatically enforced by shortages of material and restrictions on capital investment. It is not so easy to assert that there has been any general improvement where these restrictions have not applied and, in large projects involving many acres of land, other government departments have often shown scant respect for their Cinderella sister.

Public awareness of the problems of planning is steadily increasing and the Ministry has done much to clarify them; such publications as the ten-mile Planning Maps and the reports of the mineral working committees will remain as monuments to its work after much else has been forgotten. As local planning authorities are always complaining, one cannot prepare realistic plans without some idea of the national framework into which they must fit.

It is asserted in the last chapter of the report that "in nearly all those sections of the Ministry's work which have been described in previous chapters, the technical staff works so closely with the administrative and executive staff that no attempt has been made to distinguish between the contributions of the technical and administrative sides." One may question whether the Ministry's record does in fact demonstrate that its "administrative" and "technical" officers have always worked in harmony, but town and country planning well illustrates how out of date is the traditional civil service distinction between the two functions. This is recognized on the local and regional plane in the Schuster Report [1] and is equally applicable to national planning.

The appendices include useful lists of official circulars and of planning schemes and reports published under the general aegis of the Ministry. F. H. W. G.

CAVE MEN NEW AND OLD. By NORBERT CASTERET. (Translated by R. L. G. IRVING.) *London: J. M. Dent*, 1951. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xiii + 178 *pages; diagram and illustrations.* 16*s*

Norbert Casteret's reputation as a writer and an explorer of caves was firmly established in this country with the translation of "Ten years under the earth"

[1] See *Geogr. J.* 117 (1951) 248–9.

and the first part of this collection of accounts of caving expeditions and allied topics sustains that reputation. One is filled with wonder at the tenacity, skill and courage of the author and his companions in their successive assaults on the Central Pyrenean pothole of la Henne Morte, which up to 1948 was the deepest known cave in the world. The final exploration in 1947, assisted by a large supporting party organized by Felix Trombe, occupied five days and six nights and reached the record depth of 1463 feet. The serious student of karstic phenomena will however find little scientific information in this account; though Trombe has covered it in his 'Le mystère de la Henne Morte' published in 1948.

The description of the conquest of la Henne Morte is followed by an account of the celebration of Mass in another Pyrenean cave, famous for its gypsum decorations, the Grotte d'Esparros; by a brief survey of the role of caves in mythology and religious writings, a discussion on thunderstorms and caves and, finally, a short essay on the origin of the traditional calls of mountain folk. In the chapter on thunderstorms, Casteret carefully considers his own observations and those of others before reaching the surprising conclusion that there is a connection between caves and lightning discharges. In contrast, the excursion into folklore and hagiology shows little critical treatment.

Except for the section on thunderstorms, the contents of this book appeared in France under the title 'Exploration' in 1949. Mr. Irving has made a good translation though speleologists will sometimes find his interpretation of French caving terms rather unsatisfactory. G. T. W.

BACKGROUND TO SWEDEN. By TERENCE HEYWOOD. *London: Constable, 1950. 9×5½ inches; 332 pages; end map and illustrations. 25s*

'Background to Sweden' is an appreciation (almost an idealisation) of a country in which the author finds a second home. It is an anthology, uneven in quality, of regional impressions from Bohuslän skerries to the disputed borderlands of Härjedalen and Jämtéland; of historical digressions which open windows on eccentric Christina, Scottish mercenaries, skiing lore and Swedish witchcraft; and of poetic expressions. Quotations from both well and little known sources are scattered throughout the text, but there is a noticeable absence of references to historical works from which the author must have obtained much data. The Swedish background described has an essentially rural accent and, since the author has a silvicultural and ecological training, it is not surprising that the chapter on forests should be among the most satisfying. All ingredients which give popular flavour to the Swedish country scene are included—crayfish and wasteland berries, midsummer poles and *fäbodar* (summer shielings), the delicate *Linnea borealis* and the garish waistcoats of the forestry students. Full letters from term-time Uppsala, against its background of winter exhilaration and spring discomfiture, add a useful student picture. Descriptions of neglected Öland and unknown lake islands balance those of the wilder fells and Lapland. Throughout, the book has a commendable accuracy in detail. It makes no pretence whatsoever to be a geographical study and must not therefore be judged by academic standards. To a reviewing geographer however it serves as a reminder of the continuing absence of a geography of Sweden in the English language. W. R. M.

GELÄNDE UND KARTE. By EDUARD IMHOF. *Erlenbach-Zürich: Eugen Rentsch Verlag, 1950. 10½×7½ inches; 256 pages; maps, diagrams and illustrations. 42s*

This interesting work has two objects: to spread an understanding of maps in association with "an eye for country"; and to explain the system and content

of the National Map of Switzerland. It has been written less for the surveyor or cartographer than for the general map user, but nevertheless its scope is very comprehensive and many aspects of cartography are dealt with, though some rather summarily.

As the author emphasises in the opening pages, the book is as much a guide to the recognition of the character and form of surface relief in the field as to the interpretation of maps, either of these faculties being incomplete without the other. Since the book is written primarily for the Swiss public most attention is given to mountain relief, and much of it should be of value to mountaineers. The early sections deal with the estimation of distances and heights, the varying appearance of topography from different altitudes and under different conditions, features which mask or reveal the true surface configuration, and similar topics. The form and content of maps in general is then dealt with, followed by a short account of map production. A description of the principal maps of Switzerland follows, and the remaining chapters deal with map reading (briefly), simple methods of measurement in the field, route-finding in the mountains and maps as geographical documents. Of great interest are the ingenious diagrams, the numerous landscape sketches, mostly by the author, the photographs and the reproductions in full colour of portions of Swiss maps (all of which elucidate the text and illustrate the full range of the new National Map). The illustrations alone are worth the attention of students of cartography. The publication of the 1 : 50,000 series was begun in 1938; the new 1 : 25,000—which will be the most detailed map of Switzerland—has not yet appeared, but when the programme is complete the country will be mapped on a standard unexcelled elsewhere. G. R. C.

ASIA

THE CHANGING MAP OF ASIA: a political geography. Edited by W. G. East and O. H. K. Spate. *London: Methuen* (*New York: E. P. Dutton and Co.*), 1950. 8½×6 *inches;* x+414 *pages; maps.* 25*s*

The apt title of this book is an indication both of its scope and of the difficulty inherent in the subject. We think rightly of the political map of Asia not only as changed greatly within the past few decades, but as changing almost from day to day. Clearly it is only possible to present a snapshot picture—or better a series of pictures—as nearly up-to-date as the exigencies of publishing will allow. This the editors and their collaborators have done superlatively well. The physical maps of Asia have also changed. It is not that mountains have arisen where none existed before, or that the geology has altered, but our knowledge is constantly extending and the maps must be changed accordingly. There was always oil in the Persian gulf area but its discovery has altered the whole economic picture.

The two editors contribute the introduction entitled "The Asian background" and the epilogue entitled "The unity of Asia?" The Continent has been considered as comprising six "realms." The first, South-west Asia, is dealt with by Walter Fogg; the second, India and Pakistan, by Professor Spate; South-east Asia by C. A. Fisher; the Far East by Dr. H. J. Wood; Soviet Asia by Professor East, and High Asia by R. R. Rawson. Each section though differing in style and detail follows the same general pattern: a rapid sketch of the physical setting followed by a consideration of the historical geography leading up to a study of the political and economic geography of the present where outstanding factors such as oil in the south-west, state-structure in India

and demographic problems in the Far East are high-lighted. Each section is followed by statistical tables and a helpful bibliography.

Throughout, this is a scholarly work; every page bears witness of the wide reading and analytical insight of the authors and editors. In particular the editors write with an exceptional command of the English language. At the same time it is not always an easy book to read. The thirty-four maps deal mainly with special features and a familiarity with both the general geography and the ordinary maps of Asia is presumed. The book does not therefore take the place of a geography text; it is complementary thereto. Not only does the student need this preparation; he will find himself referring if he is conscientious, and not always successfully, to a dictionary to appreciate fully what may otherwise appear to him but a spate of words. Examples of words and phrases presenting such difficulties are "chalcolithic" (p. 4), "lateritic aprons and diluvial terraces" (p. 5, but is this correct?), "an extrusion of the European oecumene" (p. 6), "glacis" (p. 20), "artisanate" (p. 24), "caprine activity" (p. 121), "sinicized" (p. 189—if such a word *must* be created surely it would be better "sinocized") and "theogony" (p. 122). Their use suggests that the beauty of simplicity has been overlooked. Indeed there are cases when translation into simple English leads one to doubt the veracity of the ideas cloaked in erudite phraseology, for do not the phenomena of Iraq and Saudi Arabia give the lie to "Southwest Asia fissiparous, and rendered more so by the poverty in men and technique and its wealth in oil, as well as its *damnosa haereditas* of an unrivalled strategic position . . ." (p. 305).

Public memory is short and a few words of explanation would have rendered intelligible to a wider audience passing references such as to Ferry's imperialism (p. 18) or Wendell Willkie's world flight (p. 39), or "the spirituality of the East has been exaggerated . . . grotesquely . . . by Californian neophytes" (p. 12). Similarly, the numerous mixed metaphors may stretch the imagination, though others are telling in their penetration, as with the use of schizophrenia on page 26, or the reference to the "close stipple of unnucleated settlements, almost amphibious in the rains" of Bengal (p. 121). Some phrases enshrine in lucid perfection important concepts, "the revolt of the clerks" (p. 25); but others leave one puzzling, "the wind-impregnated saline lakes of Rajputana" (p. 143). Others sacrifice too much—*e.g.* languages as "tribal splinters of no account" (p. 133).

It would be unfortunate if these small comments were allowed to detract from the appreciation of a stimulating and vital book, aptly to be described as one of the most important contributions to the study of Asian problems which has appeared in recent times. It has the particular virtue of being objective in the study of a subject where it is difficult to avoid the expression of personal opinions. This is especially true of the sections on the Far East and High Asia.

L. D. S

THE PIVOT OF ASIA. By OWEN LATTIMORE. *Boston: Little, Brown*, 1950. 8×5½ *inches;* xiv+266 *pages; maps.* 28*s*

The type of work nowadays being carried out under the heading of "area studies" in a number of leading American universities is excellently illustrated by this recent volume, which represents the combined efforts of the team of specialists taking part in Dr. Lattimore's Inner Asian Seminar at the Walter Hines Page School of International Relations.

The group included, *inter alia*, experts on geography, economics, politics, linguistics, art and archaeology and, although the work of most members was devoted more to certain limited parts of the book than to the remainder, all the

subject matter has been discussed in full session and the work has been given a measure of unity by the practised and deft editing of Dr. Lattimore himself. The advantages of such co-operative research into the problems of little-known areas, in this case Sinkiang, are apparent from a reading of this study which brings out on innumerable occasions the inter-relations between matters that individual specialists might otherwise have regarded as their own particular preserve. On the other hand it must be admitted that the sequence of chapters is somewhat surprising, and it would probably have made for greater clarity to have considered geography and ethnology before, rather than after, the discussions of Anglo-Russian rivalry and Chinese policies.

An extremely sensitive perception of geographical values is evident throughout the book, and perhaps especially so in the illuminating comparison drawn between the continental and maritime forms of imperialism respectively practised by Russia and Great Britain during the nineteenth century. The geographer will also find much of interest in the sections dealing with pastoral nomadism and oasis farming and in the appendix devoted to international boundaries in the Pamirs, which gives a clear and concise summary of an extremely complex situation. In the final chapter, "At the crossroads of Inner Asia," the conflicting interests of foreign powers in Sinkiang are analysed with a restraint and clarity which is the more commendable in view of the highly charged emotional atmosphere which so often pervades discussion about this area today. It is difficult to resist the conclusion that the geographical and economic forces tending to link Sinkiang with the U.S.S.R. are fundamentally stronger than the ties which bind it to China. But Dr. Lattimore wisely refrains from wishful thinking about the prospects of Sino-Soviet discord over this matter.

The book is well produced, and the sketch-maps, though in no sense elaborate, are pleasing to the eye and adequate for their purpose. C. A. F.

AUSTRALIA AND PACIFIC

NEW ZEALAND, 1826–1827; from the French of Dumont D'Urville. An English translation of the *Voyage de l'Astrolabe* (in New Zealand waters) with an introductory essay by OLIVE WRIGHT. *Wellington, N.Z.: The Wingfield Press* (for the author), 1951. 10×7½ *inches;* xii+252 *pages; maps and illustrations.* 30*s*

It is strange that no translation of Dumont D'Urville's narrative of his voyage round the world in the years 1826 to 1829 should have appeared in English. Miss Olive Wright has remedied this so far as D'Urville's work in New Zealand is concerned, thus providing the New Zealand public with the record of an important episode in their country's history, for D'Urville spent three months off the North Island in 1826, some fifty years after Cook's exploration. The translation is straightforward and reads easily and, except for an occasional footnote, Miss Wright has allowed the narrative to stand by itself. Much of it is naturally concerned with details of navigation and of the hydrographical survey which D'Urville pursued with determination. He was also a botanist of some standing and, above all, took a keen interest in the native peoples and their manner of life. He was at particular pains to obtain native names for prominent features, and one of his rare criticisms of Cook is that he had given English names to them, " often in rather poor taste." D'Urville's publications include a systematic account of New Zealand which Miss Wright also proposes to translate.

Her studies led the translator to an interest in D'Urville's career and she has added a very useful biographical sketch which contains details not hitherto

readily available in English. He was a man of great force of character, active, and of a scientific turn of mind. Unfortunately, he came to think that his achievements were not suitably recognized in scientific circles; he failed, for example, to secure election to the *Institut*. He had undoubtedly suffered hardships and personal loss in pursuing his aims, and the lack of recognition may have been due in part to the circumstances of the times.

The translator has added useful Appendices on other French navigators in the Pacific and on French scientific institutions, but the maps are inadequate. The book is a very creditable production, carried out entirely at the author's expense, and it is to be hoped that her enterprise will receive the support it deserves. G. R. C.

ECONOMIC GEOGRAPHY

WORLD GEOGRAPHY OF PETROLEUM. By W. E. Pratt and D. Good. *New York: American Geographical Society (Special Publication No. 31), 1950. 10×6½ inches; xviii+464 pages; maps and illustrations. £2 8s*

This admirable summary of the world situation in oil appeared a year ago in response to an initiative of the American Geographical Society and provides much topical reading. It is the work of some twenty contributors with an aggregate of knowledge extending from the United States to Indonesia and moving from an exposition of the geological factors in oil forming processes to a survey of the political, social and strategic problems besetting us today. The treatment of petroleum questions is necessarily in a large measure statistical, and to this extent the book is more for reference than for reading. It is a disappointment that a professional volume produced in mid-1950 is often statistically complete only down to 1947; for example, the comparative table of production on page 406 fails to disclose that, since that date, Middle East production has been overtaking that of the Caribbean.

Among some notable contributions the most stimulating are perhaps those of Dr. Lees, who seasons a science which has brought him within the Royal Society with a humanist perception of history, and of W. E. Pratt, one of the editors, who has much of surpassing interest to tell of the so-called continental shelves and the arctic wastes as potential oil-producing grounds. In 1945 President Truman claimed the contiguous 100-fathom shelf as appertaining to the United States. Recent proceedings in the Persian Gulf have not shown conclusively how far such a claim will prove reconcilable with international conventions relating to territorial waters, or how it can be applied to shallow inland seas with a multitude of riparian owners. Turning to history, Dr. Lees hits the mark when he writes "Throughout the centuries Persia has demonstrated a capacity for balancing on the brink of administrative chaos and yet being steadied time after time" and his quotations from Herodotus are good fun.

It is interesting to see that this authoritative book endorses, though with comforting qualifications, the statement that the proved oil reserves of the United States are only twelve times its annual consumption. The reader may be concerned to balance against this the statement on page 326 that the proved reserves in the Middle East are nearly as large as those of all the remainder of the world. It is a pity that the account in this book of the original discovery at Masjid-i-Sulaiman in 1908 does not give the honour to G. B. Reynolds, following the dramatic story told by Sir Arnold Wilson and endorsed by Sir John Cadman.

An interesting chapter deals with the reserves, proved or prospective, in

Soviet Russia and stresses the geological similarities between the Russian landmass and North America.

Much more might be said of this book, but the following quotations are of more than local application. ". . . The best interests of the peoples demands that this apparent conflict of interest be resolved. There exists a large area where the true interests of both governments and foreign oil companies run parallel." . . . "We must use petroleum to develop Venezuela instead of permitting her future to be diverted by the violent torrents of wealth produced by that industry and by all the special conditions its existence brings about day after day." Even these comments ignore the fact that oil is a wasting asset.

O. K. C

MEN AGAINST THE DESERT. By RITCHIE CALDER. *London: George Allen and Unwin*, 1951. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches; 186 pages; maps and illustrations. 12s 6d*

Can mankind do anything effective to utilize the great deserts which occupy nearly a third of the whole land-area available to his ever-increasing numbers? And is anything being done? It was to seek answers to these questions that Mr. Ritchie Calder undertook, on behalf of UNESCO, the journey he describes in this book. The undertaking was publicized on the grand scale and became an interesting venture in mass-education, as readers will no doubt recall from contemporary press and radio accounts. Mr. Calder traversed over 8000 miles of North Africa and the Middle East, visiting desert research stations and conservation and reclamation projects in eight different countries. In Algeria he saw the research station at Beni Abbes, and the imaginative scheme for utilizing, by wells and underground tapping, the enormous quantities of water normally lost by evaporation from the interior-drainage "sump" of the Chott ech Chergui. Eastwards, through Tunisia, Libya, Egypt, Iraq and Persia, he saw a wide variety of experiments in putting to profitable use underground waters, the occasional flood run-off of wadis, and even night dews; and of methods in stabilizing mobile sand and transforming it into useful soil. It was in Israel however that he encountered the most extensive and vigorous efforts to conquer the desert. Here all the resources of modern science are apparently being used to reclaim the Negev. Among many interesting developments, particularly intriguing is the use of flake nylon floating on the water to cut down evaporation from open reservoirs, and of the wild castor-oil plant as a somewhat unexpected source of raw material for this substance. The imaginative scheme proposed some years ago by Dr. Lowdermilk, to divert the entire Jordan for irrigation and let the Mediterranean waters into the Rift Valley for power development, is still held up by political difficulties, but on other fronts the attack on aridity is clearly being pursued with vigour and ingenuity.

What are we to conclude from Calder's survey? He writes with great enthusiasm, and conveys to the reader the impression not only that the great deserts have been much extended over historic time by man's own folly in destroying vegetation and maltreating the land (which is probably in large measure true), but also that modern science can now enable us so to transform great areas of desert that they could contribute substantially to the world's food-supplies. This second conclusion seems to demand a word of caution for, leaving aside the technical difficulties, no consideration whatever is given to the question of costs. Effective alteration of the basic climatic conditions of the great deserts is, and may well always be, entirely beyond man's powers, and the useful modification of more than a small favoured area round their edges may prove economically not worth while. Although spectacular improvement

schemes like that of the Chott ech Chergui must command admiration (and all useful research should obviously be encouraged) it would therefore seem wise to devote at least as much attention to teaching the native inhabitants how to make better use of their available land and water by cheap and simple means, as Professor Debenham has urged in the pages of this *Journal* for East and South Africa. It seems doubtful if the real deserts, however much science is applied to them, will be able, under any foreseeable conditions, to produce a surplus of foodstuffs sufficient to affect world markets appreciably.

Mr. Calder's book is however interesting and readable while the photographs, taken by Mr. Raymond Kleboe of *Picture Post*, are first-class. The same cannot be said for the small sketch-maps which are often too small and diagrammatic to help the reader to follow the author's journeys. R. F. P

GENERAL

GEOGRAPHY IN THE TWENTIETH CENTURY. Edited by GRIFFITH TAYLOR. *London: Methuen (New York: Philosophical Library)*, 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* x+630 *pages; maps and illustrations.* 30*s*

This work fails to provide what its title and brief editorial preface appear to promise, namely an assessment of the present trends of geography as a study, in the light of its progress during the last fifty years. Such a task was well worth undertaking for few would deny that geography has many advances to record in this period, alike in its fields of research, in education, and in its application to current affairs. Although the editor enjoys a signal advantage over his colleagues in that he is cognizant of "Nature's plan" (p. 16), he can scarcely claim to have devised the carefully balanced plan necessary for the successful exposition of the title theme. Given the wide range of geographical study and its intermediate position between the arts and the sciences, it is the more regrettable that 'Geography in the twentieth century,' as a book, has not been so organized as to portray geography as a unitary discipline. It offers ground once again to critics who see it only as a remarkable miscellanea.

This general criticism can be briefly illustrated. Whereas the book gives us interesting appreciations of the French and German schools of geography, we are left to infer that either there are no American or British schools as such or, if there are, that they scarcely merit separate discussion. Again, whereas some of the main branches of geography are examined systematically, or specifically illustrated, others are ignored. Geomorphology, meteorology, social, political, urban, applied, and even racial geography engage the attention of a number of the contributors, but cartography, together with historical, economic and regional geography, are accorded only incidental notice. It is doubtless fitting that the book should include essays on Arctic and Antarctic exploration and on the role of geographical societies.

"Geography," Dr. Putnam tells us (p. 395) has been defined as "what geographers do." 'Geography in the twentieth century' is, beyond doubt, geography in this sense. Its effect on the attentive reader is at once exhilarating and disheartening; for while the book lacks intellectual and artistic unity, leaves so much unsaid and yet says too much, it is a symposium from which the reader can select at will chapters which enlighten, stimulate, irritate, or offend. Specimens of the work of twenty geographers, mainly drawn from England, Canada and the United States, and many among the best known, here jostle together. The student, his attention drawn to this book as it should be, will find stimulus and profit by reading some of these essays, the work of experts writing on their own specialisms: K. J. Pelzer on "Geography and the tropics,"

S. W. Wooldridge on "The progress of geomorphology," J. W. Watson on social geography, Griffith Taylor on Antarctic exploration, F. K. Hare on meteorology, E. W. Gilbert on regions (some of which, though outmoded, live on, while others are the unwanted creations of the geographer's mind). The most impressive essay is by Isaiah Bowman on "Settlement by the modern pioneer" which, by its sheer intellectual quality and literary expression, at once vindicates geography as an intellectual discipline and shows how indispensable is its thinking to the settlement and development of the remaining pioneer lands.

The student, granted this rare chance of conveniently comparing the writings of his teachers, will learn also what to avoid. He will note that the "dynographs," shown on p. 594, offer a technique which misleads; he will perhaps ponder, as did this reviewer, on "the zones and strata concept" (p. 445–447) and the diagrams to which it leads. He will doubt whether an equation can really express the major features of a small town, and whether the "seven ages of a town" afford a worth-while classification of the stages of urban growth (pp. 524–526). If he is what Griffith Taylor would style a "landscape gardener" type of geographer (see p. 9), he will not readily believe that Sevenoaks, Dorking and Guildford lie in the Gault vale and will note the confusion of Watling Street and the Pilgrim's Way (p. 514). He will pause before he shares Griffith Taylor's attraction to Mumford's verbal infelicities (p. 507); he will wonder (for he is not told) why, because the land of Britain has been used, and very variously used, for one to two thousand years, its present utilization is more important than that of more recently developed lands (p. 376). And lastly as he reads this book, if wide awake, he may reflect a little about the meaning of technical terms, concepts and even words when he finds that a discussion of towns extends to villages and that, under the sub-heading *Geography of Medieval Towns* (p. 506), the steam engine and the conurbation are very much in evidence. W. G. E.

THE SPIRIT AND PURPOSE OF GEOGRAPHY. By S. W. WOOLDRIDGE and W. G. EAST. *London: Hutchinson's University Library*, 1951. $7\frac{1}{2} \times 4\frac{1}{2}$ *inches; 176 pages; sketch-maps. 7s 6d*

Twenty or thirty years ago this would have been an admirable book to put in the hands of those disciples of the earlier academic disciplines who, in complete ignorance of the geographers' aim, strenuously opposed the entry of geography into the academic curricula, or, if the subject gained a precarious footing, it was successfully barred from the senate and higher planes of university study. In recent years all that has changed; geography in most universities has triumphed. Universities instead of being impecunious have money to burn, and have given geography professional rank along with many subjects that have a far weaker claim. The book however has another use: it shows the student what is the scope and content of his subject, and if a little prolix in places, it is an admirable presentation of the geographer's standpoint and a discussion of some of his difficulties. Few geographers will quarrel with the author's conclusions, for there is by now a general consensus of opinion as to the spirit and content of the subject. We note a cautious attitude in warning readers of the false dichotomy between physical and human geography, and with regard to the latter, the danger of looking for formal categories and universal principles as in the former. It is in bridging the gap between physical and human distributions that geography has its main importance. The authors regard the physical side as no more basic than the social, or human, side as might be expected from their own special academic interests. As regards regional geography, they find very attractive the concept of the region as attached to the urban centre, while

warning geographers of the danger of facile analogies with biological truths and terminology. One must however remember that without theories, right or wrong, there can be no progress. Economic geography despite all that has been written on that subject, "has not yet advanced so far as to have established its position beyond question and to have differentiated itself clearly from other branches of the whole subject." That is a pregnant remark that will cause some thought. In teaching it is difficult to make useful progress without a division of the subject at all stages, and with all outlooks there is room for the specialist without whom no progress can be made. The determinism of Ratzel is not dead, but the authors touch it very lightly and reasonably ask for more evidence. It is however by the writers of geographical books and papers that the subject will come into its own and justify its point of view. It has moved far from the old purely descriptive monotony of lists of locational and economic facts.

R. N. R. B.

KLEINE LÄNDERKUNDEN: UNSER WISSEN VON DER ERDE. Edited by W. EVERS. (Seven volumes.) *Stuttgart: Frankhsche Verlagshandlung, 1950–51; maps, diagrams and illustrations. Various prices*

These latest additions to the clearly written and well-produced series, 'Kleine Länderkunden' cover a wide variety of countries and regions. They are designed for the general reader who wishes to be informed on the principles and fundamentals of geography, especially in their bearing upon political developments, economic resources, and international relations. The authors are geographers, in most cases with personal knowledge of the areas about which they write. Each volume is supplemented by statistical tables and a bibliography, mainly of references in German. It is possible here to refer to one or two only of those recently issued. Professor Arved Schultz's 'Der Erdteil Asien' is designed as a general introduction to volumes on particular Asiatic countries. Ethnography is especially dealt with, but, within the limited space available, most aspects receive some notice. In 'Grossbritannien und Irland' J. H. Schultze brings out the main characteristics, though some of the finer points are missed; in spite of difficulties, a serious attempt has been made to incorporate up-to-date statistics. The publications of the Land Utilisation Survey are not mentioned, and the 1 : 25,000 map is omitted from the list of O.S. Publications. The term 'Irischer Freistaat' is employed. In the general section of the series, Dr. Aurada has written a concise account of the structure of the Alps and the evolution of their forms. His 'Steinernes Wunderland' has numerous diagrams and some attractive photographs. Other recent volumes include accounts of Australia, Japan, Finland, and the Sahara. G. R. C.

THE STUDY OF LOCAL GEOGRAPHY. By C. A. SIMPSON. *London: Methuen, 1950. $8\frac{1}{2} \times 6\frac{1}{2}$ inches; viii+68 pages; maps. 6s 6d.*

This is a new edition of a useful book first published in 1934 and already well known to many geography teachers. Much of its advice is now common ground among them and, as the introduction notes, there now exist other publications that will supplement it. Suggestions for the investigation of such things as physical and geological features, climate, agriculture, communications and town and village sites are illustrated by five black and white contoured maps (unfortunately not located) at the end of the volume. "Only minor alterations" have been made to bring the original text up to date; for example the 1 : 25,000 map is referred to only in a footnote. No doubt teachers will continue to find the book useful. E. W. H. B.

THE SOCIETY'S NEWS

THE NEW PRESIDENT AND COUNCIL OF THE SOCIETY

Among the elections made at the Annual General Meeting on June 25 are those of Mr. J. M. Wordie as President and Professor Debenham, Brigadier Hotine and the Bishop of Portsmouth as Vice-Presidents.

Mr. J. M. Wordie, C.B.E., is President and Senior Tutor of St. John's College, Cambridge, and Chairman of the Scott Polar Research Institute at Cambridge. He was a geologist on Shackleton's Antarctic expedition of 1914–17 and has been for many years Honorary Secretary of the Society. Professor Frank Debenham, O.B.E., who recently retired from the Chair of Geography at Cambridge was the first Director of the Polar Research Institute; he was a geologist on Scott's Antarctic expedition of 1910–13. Brigadier M. Hotine, C.M.G., C.B.E., is Director of Colonial Surveys and was elected to the Council in 1948. The Rt. Rev. W. L. S. Fleming, Lord Bishop of Portsmouth, was Chaplain and geologist to the British Graham Land Expedition, 1934–7. He too has been a Director of the Polar Research Institute and was elected to the Council in 1947.

A new Trustee of the Society is Marshal of the Royal Air Force Sir John Slessor, G.C.B., and a new Honorary Secretary is Lieutenant-Colonel Andrew Croft, D.S.O., who has travelled in Greenland and was a War Office observer on Exercise "Musk Ox." General Sir James Marshall-Cornwall, K.C.B., a Vice-President of the Society, becomes Foreign Secretary.

Members of Council who have not previously served are Dr. E. W. H. Briault, of the Education Department of the London County Council; Professor R. Ogilvie Buchanan, of the London School of Economics; Sir Laurence Collier, K.C.M.G., recently British Ambassador to Norway; Rear-Admiral A. Day, C.B.E., Hydrographer of the Navy; and Sir Clarmont Skrine, formerly of the Indian Civil Service and the Indian Political Department, holder of the Gill Memorial and widely travelled in Central Asia and the Middle East.

THE NORWEGIAN–BRITISH–SWEDISH EXPEDITION, 1949–52

This first international Antarctic expedition, whose progress has been reported periodically in dispatches in *The Times*, is now drawing to a close. The Norwegian sealer *Norsel* has been chartered once again for the final voyage and will leave Norway in October, carrying two British observers and two aircraft and a unit of the Swedish Air Force, under the command of Captain von Essen. Next year, *Norsel* will bring the whole expedition home, leaving the Antarctic continent towards the end of January or early in February. Apart from the relief of the base, the main objective of this season's voyage will be a programme of air photography and survey by the Swedish Air Force to cover those parts of the mountain region where the field parties have worked, and the barrier to the east and west of the base "Maudheim." The aircraft carried will be a "Beechcraft" and a "Safir," with float equipment. While survey will have priority this season, work will continue on glaciology and seismic research which have both yielded very important results.

Plans for this final season were discussed at a meeting in Oslo in June, attended by the President of the Society, Mr. Wordie, by Dr. Roberts of the Scott Polar Institute, and the Director and Secretary. The meetings were held at the Norwegian Polar Institute, under the chairmanship of its director, Professor Harald Sverdrup, and Sweden was represented by Professor Hans

W:son Ahlmann, now Swedish Ambassador to Norway, and by Captain von Essen of the Swedish Air Force. The British observers to go south this year have not yet (July) been selected, but it is hoped that one will be a British naval officer to continue the valuable work done last year by Lieutenant Foster, R.N., on ice navigation and other observations.

MOUNT EVEREST RECONNAISSANCE EXPEDITION, 1951

The conquest of Everest has for many years been one of the interests of the Society which, with the Alpine Club, has been joint sponsor of all previous attempts to climb the mountain. Since the war, the joint Himalayan Committee of the Society and the Club, formerly the "Everest Committee," has more than once discussed plans for another expedition. Any attempt from the north, from Tibetan territory, is now unfortunately out of the question for political reasons and it has therefore been decided to send out a reconnaissance party to explore the south-western area. A map of Everest in production by the Society (based on air photographs taken by the Houston-Everest Expedition of 1935) and other surveys show the area to be worth at least a close examination.

The prospects are not bright and little, if anything, is known of weather conditions on this face. But the south ridge seems a possible route to the summit and the exploration of the approaches to the south col, at the foot of the ridge, is the main objective of this year's expedition. It will be led by Eric Shipton, a Gold Medallist of the Society and a distinguished Himalayan mountaineer, and will include W. Murray, leader of the 1950 Scottish Himalayan Expedition, Michael Ward and T. Bourdillon, the latter with previous experience of Alpine though not of Himalayan climbing. Permission has been granted by the Nepalese Government and the expedition hopes to return in December of this year with sufficient information to say whether a main assault from this side is a practical proposition.

FIFTH GENERAL INDEX TO THE *GEOGRAPHICAL JOURNAL*

The Society has just published the Fifth General Index to the *Geographical Journal*, volumes 81 to 100 (1933 to 1942). In addition to the index of topics and persons, there is also a classified list of all papers published in these volumes of the *Journal*. The Index is obtainable from the office of the Society, price 21*s* (to Fellows, 16*s*) plus postage. The preparation and publication of works of this character is a heavy charge on the Society's funds and it is hoped therefore that all institutions and individuals possessing sets of the *Journal* will complete them by purchasing this Index. Copies of the first four General Indexes (1893 to 1932) can still be obtained, price 20*s* each (to Fellows, 15*s*) plus postage.

"ADDITIONS TO THE LIBRARY AND MAP ROOM"

With the resumption of the separate publication of lists of recent geographical literature and maps, referred to in the last issue of the *Journal*, it has been decided to discontinue the section of the *Journal* devoted to "Additions to the Library and Map Room."

WATKINS AWARDS

The Watkins award for 1951, a sum of £50, has been made to Mr. D. J. Atkinson, of the Imperial College of Science and Technology, London University, for geological work in Prince Charles Foreland begun in 1950 and to be continued this year. The Watkins award was not made in 1950 but has now been granted to Mr. H. Lister of Fitzwilliam House, Cambridge, who was

leader of the Durham University Expedition in 1949 and will continue his glaciological work in Iceland this year.

A grant of £10, in addition to a similar grant held over from last year, has been made to Miss M. C. Findlay of Girton College, Cambridge, for anthropo-geographical work in West Greenland.

The Gino Watkins Memorial Fund is administered for the Scott Polar Research Institute by a committee appointed by the Society and Martin's Bank Limited, the joint Trustees of the Fund. Equipment provided from the fund is also being lent this year to the Cambridge Spitsbergen Expedition and the Cambridge Jotunheimen Expedition.

THE RECORD

CONTRIBUTORS TO THIS ISSUE OF THE *JOURNAL*

Mr. H. W. Tilman, D.S.O., is already well known for his expeditions to the Himalayas and in the mountains of East Africa; he was leader of the 1938 Mount Everest Expedition. *Miss H. M. Wallis* recently joined the staff of the British Museum as Assistant Keeper in the Map Room, where she is compiling a catalogue of early globes in British collections. *Mr. A. T. Grove*, at present a Demonstrator in the Department of Geography at Cambridge, was employed by the Nigerian government at the recommendation of the Society to study the geographical aspects of soil erosion in that country. *Sir Clarmont Skrine*, O.B.E., formerly of the Political Department of the Government of India, is a member of the Society's Council. *Dr. A. F. A. Mutton* is a lecturer in Geography at Queen Mary College, in the University of London, and has travelled widely in Europe; she has recently extended her study of hydro-electric development to the stations in Norway. *Professor C. A. Cotton*, Professor of Geology at Victoria University College in the University of New Zealand, is already well known for his writings on geomorphology. He was this year awarded the Society's Victoria Medal. *Mr. M. A. U. Heathcote* is a settler in Kenya who has long been a Fellow of the Society and has previously contributed papers to the *Journal; Mr. J. B. Carson* is an administrative officer in Kenya.

THE SNOW SURVEY OF GREAT BRITAIN

When the Association for the Study of Snow and Ice (founded in Edinburgh in 1936) became the British Glaciological Society at the end of the war, the survey of snowfall in Great Britain was reorganized under the direction of E. L. Hawke and D. Champion. It is now carried out by a body of about 130 voluntary observers scattered all over the country, who record on cards the number of days on which snow falls at their respective stations, its average depth, the number of days on which snow drifts persist and the number of days on which snow lies at various levels within their range of vision; they also record general remarks. These data are extensively supplemented by the Meterological Office and random information is supplied by mountaineers and others. A special feature of the survey is the record of snow cover at mountain levels. The results of these researches are embodied in annual reports which, beginning with that for the season September 1946 to May 1947, have appeared in the successive March issues of the *Journal of Glaciology* from 1949 to 1951. These more exact reports should be regarded as complementary to generalized

descriptive accounts of annual snowfall going back to 1875 which have been published from time to time by L. C. W. Bonacina in *British Rainfall*; the latest, covering the decade 1936–45, has appeared in the volume for 1948 only recently published.

The Glaciological Society's reports show that the rigorous winter of 1946–47, when ice floes appeared in the North Sea, was the snowiest generally in Britain for many years, probably since 1814. After a culminating storm early in March 1947 the average depth of snow in many upland parts of Wales and northern and midland England was from 50 to 60 inches (127 to 152 cm.). In south-western England the amount of snow was thought generally, though not perhaps locally, to be greater than at any time since the memorable blizzard of 1891 and this area experienced also a devastating ice-storm, the rain freezing as it fell. Least snow fell in far western Scotland and the Hebrides, the area lying outside the track of snowy depressions. In the season of 1947–48 the general snowfall was much lighter but, on the higher mountains, falls began earlier in autumn and recurred later into the spring; in south-east England a heavy fall late in February brought conditions that in some country districts were reminiscent of the previous year. In 1948–49 there was very little snow at low levels but, again, falls occurred over a long season on the higher mountains; longer even than in the previous year. In the season 1949–50 the snowfall above 2000 feet in Scotland was the heaviest since 1946–47 and the south-east of England had its heaviest late April snow storm since 1919.

The report for 1950–51 may be expected to be as interesting as that for 1946–47; for although there was little snow at low levels after December when the weather became very rainy, conditions in the mountains were extremely severe as was, indeed, reflected in Easter fatalities in the Lakes and Snowdonia. In the Cairngorms immense accumulations of snow were still present early in May, up to 40 feet (13 m.) deep in places. L. C. W. B.

URBAN HINTERLANDS

The problem of defining urban hinterlands, discussed by F. H. W. Green in a recent paper in the *Journal*,[1] was the subject of several of the papers read to the Geographical Section at a meeting held in Uppsala under the direction of the Swedish Social Research Council in June 1950. Short abstracts in English of four of these papers have now been printed as a pamphlet, 'Studies in rural-urban interaction' in the series of *Lund Studies in Geography*. The first, by Edgar Kant, on "Umland studies and sector analysis," discusses a classification of towns and urban spheres of influence in Estonia and also includes some material on Budapest. The second paper by Sven Godlund on " Bus services, hinterlands, and the location of urban settlements in Sweden, especially in Scania" can be usefully compared with Mr. Green's article. The last two papers are both studies of the southern half of Sweden. Karl Bergsten's deals with the "Variability in intensity of urban fields, as illustrated by birth-places," while Torsten Hägerstrand's discusses "Migration and the growth of culture regions." All four papers have useful bibliographies but the abstracts themselves are so concise that they are sometimes difficult to follow.

In the discussion which followed Mr. Green's paper the use of the word "umland" was briefly mentioned. As a result *The Times* in a playful fourth leader stated that "at a recent meeting of a learned society it was suggested that the word 'umland' might be more felicitous" as a term than 'sphere of influence,' and remarked that "whatever our relation to other centres within whose sphere

[1] F. H. W. Green, "Urban hinterlands in England and Wales: an analysis of bus services," *Geogr. J.* 116 (1950) 64–88.

of influence we live, we are all in the 'umland' of Whitehall, and it really seems a much better word than hinterland, which always signified something that one wanted to get farther and farther into." The Swedish word "omland" has been translated as "umland" in these abstracts, but this word is not to be found in English dictionaries. E. W. G.

THE CHOTT ECH CHERGUI IN ALGERIA

The economy of Algeria is based primarily on sheep and on agriculture, and irrigation is necessary if the resources of the soil are to be fully developed. A programme for building large reservoirs in the Tell Atlas to irrigate the coastal plains was completed just before the war, and the post-war Chott ech Chergui scheme is of particular interest to geographers. Through the courtesy of the Service de la Colonisation et de l'Hydraulique, I was able to visit many water development schemes in Algeria in the summer of 1950, and in particular the Chott ech Chergui which is a salt lake or marsh on the High Plains. Here an area of internal drainage between the Tell Atlas and the Saharan Atlas covers 15,000 square miles and the Chott itself is about 770 square miles in area, with alluvial deposits perhaps 5000 feet in thickness.[1]

When the area was reconnoitred in 1944 [2] it appeared that the water from the springs around the Chott was fresh, which implied an artesian source, and that together they provided a flow of only about 35 cusecs.[3] The basin lies in highly permeable rocks, fissured limestone to the north and Albian sandstones to the south. The average annual rainfall is about 11 inches so that, assuming an infiltration coefficient of 5 per cent., the volume of water infiltrating annually is of the order of 20,000 million cubic feet; yet only one-twentieth of this flows from the springs and, if there is no underground leakage, the remainder must evaporate. It was therefore suggested that some of this great loss by evaporation might be captured below the surface and turned to better account.

To verify the hypothesis it was necessary to determine as accurately as possible the annual rainfall and evaporation and the infiltration coefficient; and also to determine whether there was any underground leakage from the basin, and the direction and speed of capillary water movement in the Chott. The results obtained do not disprove the hypothesis, though it is admitted that it is often impossible to obtain measurements of the desired order of accuracy. The infiltration coefficient appeared, from an experiment in a depression draining an area of about one square mile, to be nearer 12 per cent. than 5 per cent. and numerous bores around the Chott, showing that the artesian level slopes inwards, suggest that underground leakage is not serious. The annual evaporation, the most important factor, was investigated by placing frames like cucumber frames on the surface of the Chott and measuring the water condensed on their glass roofs (a conversion factor was used to obtain the evaporation from an open surface). The measurement of capillary flow has proved difficult, though such results as have been obtained are compatible with the hypothesis.

The flow from artesian bores near the experimental station at Ain Skrouna suggests that water could be drawn from the Chott in considerable quantities and a pilot project, with a capacity of 140 cusecs, is already under way. About 15 or 20 cusecs of the flow will be used to water a million or more sheep on the High Plains and the rest will go to irrigate the coastal plains a hundred miles to the north, hydro-electric energy being generated on the way. It may eventually be possible to obtain a flow of 700 or even 1000 cusecs [3] and the magnitude of

[1] 'Le Chott Chergui,' Service de la Colonisation et de l'Hydraulique, Algeria (1949).
[2] "Les tours d'horizon, d'élevage et cultures," *La Vie des Sols*, May–June 1950.
[3] A "cusec" is a flow of one cubic foot per second.

the project will be appreciated when it is realized that this is equivalent to pumping the entire summer flow of the Thames at Teddington over a range of hills 300 feet high, into a fertile plain 3500 feet below. H. W. UNDERHILL

IRRIGATION IN SPAIN

We have received from Mr. D. H. B. Perkis a note on field work carried out in Spain during the summer of 1949 by four students from the Department of Geography at Cambridge. As it appeared that little had been published in England since the civil war on the subject of Spanish irrigation, and as it was impossible to cover all the aspects of so wide a subject, a few representative areas were selected for study. It was hoped to bring back more up-to-date information on some of the older projects and news of others begun since the end of the wars. It was unfortunate that the visit coincided with what was claimed to be the worst drought in living memory.

Spain has long suffered from war and mismanagement of her land, and her troubles cannot quickly be set right; but the scope of projected irrigation works is an indication of the government's awareness of the problem. A paper on the same subject by Mr. J. M. Houston of the School of Geography at Oxford was recently published in the *Journal*.[1]

THE RECORD ROOM AND MUSEUM AT THE ORDNANCE SURVEY OFFICE, CHESSINGTON

This museum, which contains surveying instruments new and old and demonstrates the methods and processes used by the Survey, has been opened to visitors during the Festival of Britain and arrangements can also be made, through the Society, for Fellows and their friends to visit it. It is five minutes' walk from Chessington South railway station. Among the exhibits is a complete series showing the methods of air survey now being used in the revision of the large-scale plans, and the stages of compilation and reproduction by which the Ordnance maps on all scales are produced.

STONE LINES IN BOULDER CLAY AND SLIDING BLOCKS

I noticed many years ago that stone lines occurred in the boulder clay at Seahouses and Newbiggin on the coast of Northumberland and, as far as I can remember, they were parallel to the base of the boulder clay and about a foot above it; the stones themselves were rounded and much like those one would expect to find on the adjacent beach. More recently I noticed a similar line of stones in the boulder clay cliff opposite St. Mary's Island, three or four miles north of the Tyne. The stones were angular blocks of Carboniferous sandstone and, fortunately, it was here possible to see something of the way in which the line had originated. The mainland juts out towards the island in a sharpish point and the cliff on both faces consists of a solid basement of the same sandstone with boulder clay above. The stone line begins at some distance along the southern cliff and is conspicuous for a considerable distance; in the northern cliff there is no trace of the line whatever. Some of the larger sandstone blocks now littering the shore at the foot of the southern cliff evidently came from the line of stones.

It would appear that ice or boulder clay moving down the coast has incorporated blocks from the surface rock on the north side of the point and carried them southwards. A geologist who knows the area but who had not seen the phenomena has suggested to me that they are due to "rafting" by ice; it is

[1] "Irrigation as a solution to agrarian problems in modern Spain," *Geogr. J.* 116 (1950) 55–63.

evident that the earthy matter remained practically undisturbed after the removal was accomplished and the movement ceased. It is to be noted that, as at Seahouses and Newbiggin, this stone line is well inside the boulder clay and not in contact with the solid rock below. Sharpe [1] mentions the occurrence of stone lines in connection with soil creep and describes them as being "at the approximate base of creeping soil." These lines bear a certain resemblance to those he describes, although due to a different agency.

Beneath the slowly moving Northumberland ice mass there would be a fluctuating horizontal plane between the frozen matter above and the unfrozen matter below and its depth at any time would depend on the temperature gradient below the ice. When it stood at any particular depth it would enable movement to take place more easily at that level. In some such way the moving mass of ice and boulder clay may have been able to remove blocks of solid rock and carry them forward in a horizontal plane. This plane, now cut by the vertical face of the cliff, is revealed as a line of blocks and stones.

Sliding blocks

I have observed on Pavey Ark, in the Lake District, a rock mass in the form of a small pitching anticline with a well-developed system of joints in two directions at right angles to each other. There had formerly been another layer [2] of the same rock above it and its surface was spread with detached blocks from this layer which were slowly descending their individual slopes by spasmodic movements due to frost and thaw and other disturbances. Some years previously I had noticed a rock surface on the Fexthal in the Engadine which was partly bare and partly littered with detached blocks of the same material, though at the time I was quite unable to account for the apparently arbitrary line of separation. Here too the covered part was evidently a portion of a *blockmeer* or boulder spread, whereas the cleared part was a good example of the results of block sliding.

This process may well play a large part in the general denudation of the earth's surface. A diagram in James Geikie's 'Earth sculpture' illustrates the unstable condition of anticlinal mountains; two anticlines, of porous sandstones with intervening clays, are separated by a syncline; and rock falls and landslides develop on the valley sides. Each movement at the rock face on the valley side tends to unsettle the upper parts of that particular stratum and small sliding movements underground may thus weaken the superincumbent mass. Considerable weight was formerly placed on the tendency for anticlinal folding to open rock joints and for synclinal bending to close them; the effect may be extremely small, but rock falls or landslides will in this way weaken the whole structure.

T. HAY

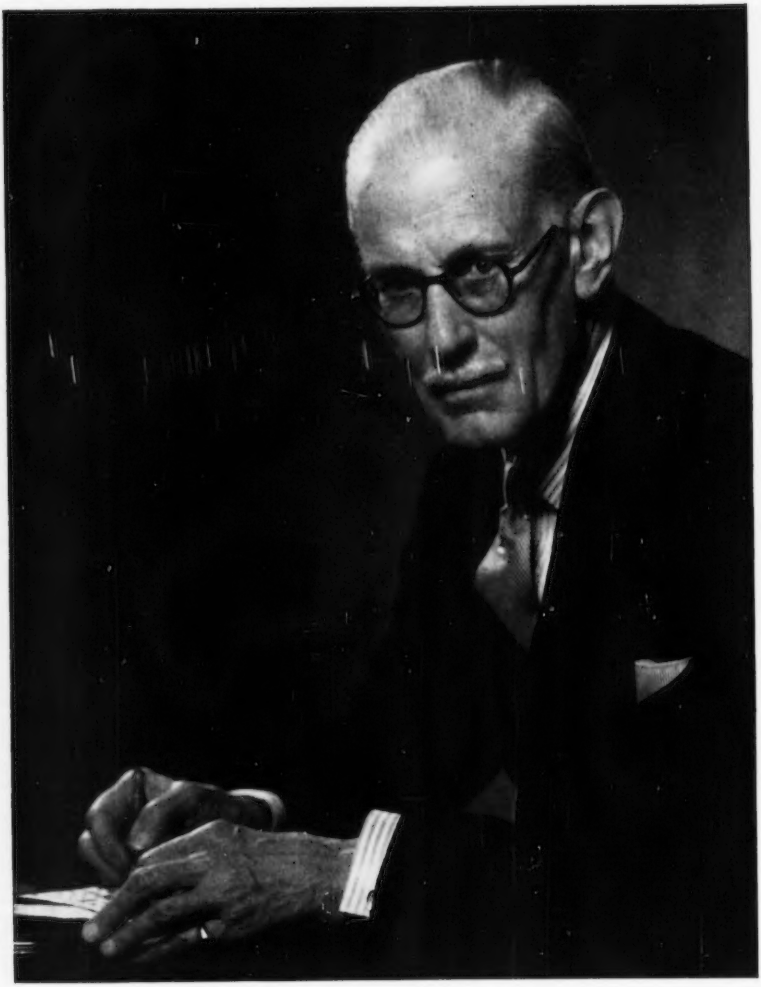
[1] S. Sharpe, 'Landslides and related phenomena,' p. 23.

[2] The upper layer can be seen in its undisturbed state in the foreground of the photograph.

Stone lines in boulder clay near Newbiggin

Stone lines in boulder clay opposite St. Mary's Island

Sliding blocks: Pavey Ark



The Rt. Hon. Sir George Clerk, G.C.M.G., C.B.

OBITUARY

THE RT. HON. SIR GEORGE CLERK, G.C.M.G., C.B.

Sir George Clerk, who died at the age of seventy-six on 18 June 1951, will chiefly be remembered by most of his countrymen for his magnificent record in the service of the Foreign Office, both at home and abroad. He has well been described as an outstanding diplomat, and Fellows of the Society were very proud of his great achievements in this field. But in the *Journal* it is his work for the Society that must be recorded. He was a Fellow for forty-seven years and served as President during the difficult war years, 1941–1945. At his first evening meeting as President, Sir George said "It is, I think, no small thing that here, in the third year of the war . . . we meet as usual, in our own house, for the normal annual opening of our regular session. As regards the proceedings of the Society itself, the shadow of the provisional hovers over all that we may propose, and we have to adapt ourselves to the difficult conditions of our day to day existence." It was largely through Sir George's wide experience of men and affairs, and to his clear thinking, that the adjustment to difficult war conditions was accomplished with the minimum of dislocation. He set firmly before him the aim of continuing the Society's work to the greatest possible extent and, except when the premises were severely damaged by bombs and the Hall was out of use for some weeks, a regular programme of meetings was maintained, and Sir George was rarely absent. He did much to secure important papers from distinguished visitors, and was alive to the opportunities which the times offered to geographers to apply their knowledge to the interpretation of the political and economic aspects of national and international affairs.

Sir George saw the war years as a sort of bridge between the pursuit of geography as it was when the Society was founded, and the form which the development of geographical knowledge was imposing upon it. He developed this at length in more than one of his annual addresses and even in his first, in 1942, he declared, "Great exploration, in the sense of first discovery, is now almost finished. There is scarcely a square mile of the Earth's surface which, even if it has not been trodden by the foot of the explorer, has not been seen from the air. But that does not mean that exploration is finished; it has only changed its character and in future will be intensive rather than extensive. The broad outline drawn by the pioneers will be supplemented in detail by the explorers of the future."

Right up to the time of his death Sir George attended meetings of the Council and of the Society's Officers, and his interest in the Society and its activities remained keen. He will always be remembered for his quick and alert mind, his clear thinking and expression, and his kindliness and good humour. But most of all his memory will be treasured in the Society for his leadership during the difficult war years. The Society showed its appreciation of this by taking the rare step of asking him to continue in office for a fourth year.

The Society was represented both at the funeral service at Golders Green and at the memorial service held at St. Margaret's Church, Westminster.

L. B.

CHRISTOPHER SANDEMAN

The recent death of Christopher Sandeman removes from the Society a Fellow of rare charm and great ability, a man of letters and leisure and a playwright at home in London. Yet he was willing to exchange this full and luxurious life for the uncertainties and discomforts of South American travel. He was educated at Eton and at Christ Church, Oxford, and had lived for considerable periods in various lands in Europe, but the changing conditions in Europe between the wars irked him and led him to seek in South America a backwater where things moved more gently.

After preliminary journeys in Peru, he chose to explore the Huallaga river and found it a happy hunting ground for the botanist. He made extensive plant collections in the lower country and sent his spoils to Kew and to the Botanical Department at Oxford while he described his journey in a book, 'A forgotten river' (1939). The Society profited from this adventure when he contributed a delightful evening lecture illustrated with some of the photographs which he recently assembled in a handsome volume on Peru, 'A wanderer in Inca Land' (1948).

Sandeman was a great conversationalist with a tremendous store of anecdotes and a love of company, yet he seemed to have an irresistible urge to undertake these lonely journeys. The last took him by unconventional methods across South America from Rio de Janeiro to Lima. J. V. H.

JOHN SWAIN

Many of the older Fellows of the Society will learn with regret of the death on August 10 of Mr. John Swain who was the first resident Housekeeper and Hall Porter of the Society when it moved to Lowther Lodge in April 1913. Mr. Swain, a native of Derbyshire, served for many years in the Metropolitan Police Force. On being pensioned from the Force, he joined the Society's Staff and remained as Head Porter until April 1932. He was a devoted servant of the Society and his strong character was always dominant in his work. When in retirement in Derbyshire he was an active member in many village associations and during the War played a prominent part in the National Savings campaign, and kept in touch with members of the Staff each Christmas. Mr. Swain was 83 years of age.

CORRESPONDENCE

I have read with some interest the small book by Dr. R. J. Harrison Church, entitled 'Modern colonization.' [1] But I find a very misleading statement in the Appendix. It is this: "As the British Colonial Office has never had a geographical adviser, it is not surprising that the British Colonial Empire was, until recently, so inadequately provided with topographical and other maps."

This statement is entirely unjustified. The Colonial Office did its best to encourage the mapping of the Crown Colonies and Protectorates in the days before the First World War, and took what steps were possible to ensure the surveying and mapping of the vast areas in question, at a time when money for the purpose was not as easy to obtain as it is now. As for the "geographical adviser," the remark could not be further from the truth.

At the instance of the Secretary of State for the Colonies, the Colonial Survey Committee was formed in 1905 for the express purpose of advising the Secretary of State on all matters connected with the exploration and survey of colonial territories, more especially those in tropical Africa, though other territories such as Ceylon, Malaya and the Orange Free State were also constantly under consideration. Those who desire to be accurately informed of the difficulties encountered, the action taken and the progress made year by year, should obtain from H.M. Stationery Office the first annual report of the Colonial Survey Committee [2] and the other annual reports of that Committee until the outbreak of the First World War in 1914.

It was the world wars, particularly the first, which hindered the progress that was being achieved in the mapping of the Colonial Empire. But much had been done up to August 1914. Those interested in the question cannot do better than study the Reports of the Colonial Survey Committee above indicated. They will there find the facts of the case. No one should write on the subject who has not studied these Reports.

C. F. ARDEN-CLOSE

21 June 1951.

[1] Reviewed in *Geogr. J.* 117 (1951) 239–40.

[2] *Colonial Reports—Annual*, No. 500, 'The surveys and explorations of British Africa: the annual report of the Colonial Survey Committee,' first year to August 1906. (Cd. 2684–46.)

MEETINGS: SESSION 1950–51

Twenty-third meeting, 16 May 1951. The President in the Chair

Paper: Map production in Great Britain. By Major-General G. Cheetham

Twenty-fourth meeting, 21 May 1951. The President in the Chair

Contemporary films: Scott's last expedition, introduced by Admiral Lord Mountevans; and the 1922 assault on Mount Everest, with a commentary by Professor G. I. Finch

Twenty-fifth meeting, 28 May 1951. Professor J. A. Steers in the Chair

Paper: An Oxford expedition to Persia. By Eric Gordon and P. H. T. Beckett

Twenty-sixth meeting, 4 June 1951. The President in the Chair

Elections to Fellowship: Etim B. Asuquo; Mrs. Vivian Bidder; George W. Blakslee; Sir Olaf K. Caroe; Mrs. A. I. H. Chatterton; James H. B. Dodd; His Excellency Eliahu Elath; Bradley Fisk, M.A.; Robert L. Goldstone; David Goodfield, B.A.; Erling V. Haines; Miss Ruth Hannam, R.A.; Norman McC. Heaney; Miss K. C. Hodgson; Leslie Jones; R. G. B. Jones; Miss K. M. Jordan; Norman Killingray; Forbes C. Lamont; Major Harold I. Lee (retd.); Dr. John C. Lockhart, B.A.; Miss Audrey Lumb; Roderick Maclaren, M.A.; Joseph Z. Mangion; Dr. L. H. Matthews; Rowland L. R. Morgan, B.SC.; Miss Liesa Nestmann; Miss Kathleen Parish; Harry Pretty; Frederick Roberts; Donald S. Scholes; Alexander Stringer; A. Thanbirajah; The Lady Tweedsmuir, M.P.; Frederick J. Vandome; Rev. Reginald White; Aldred P. Wilson

Elections to Associate Membership: Robert A. Kempster; David Michael Metcalf; Miss Jean Mitchell

Paper: Danish explorations in Central Asia. By Dr. Carl Krebs

Twenty-seventh meeting, 11 June 1951

Films: Fiji archipelago, Kodachrome films with a commentary by Dr. Telford Work

The following were elected to Fellowship and Associate Membership of the Society on 16 July 1951

Elections to Fellowship: Anthony A. Akwe; Rev. Albert S. Banks; Donald H. Blackwell; Gordon B. Booth; Rev. Dr. R. R. Brown; H. Gresham Carr; Ronald Duncan Case; Professor P. C. Chakrovorti, M.SC.; Miss Margaret J. Chaplin; Derek William Clary; Miss Josephine Collier, F.R.C.S.; Ivor Fred Cooper; C. M. G. Cox; Donald Webster Davis; C. Eccles, B.A.; Mohammed Sadek El-Halfawi, B.SC.; Peter John Evans; John Victor Firth, B.A.; Henry Martin Gillett; Ralph F. Godina-Kitchen; David W. B. Griffiths; Philip Neville Grindell; Kenelm Ernest Lee Guiness; Y. A. Haggag; Professor William Adams Hance; Leslie James Harfield; Miss Doris Harper; Miss Olive L. C. Hasler; Rev. Dr. A. W. G. Hudson; Captain William M. Hutchison; Ronald Arthur Jarvis; Stuart Legg; Edward Thomas Lill; Clifford J. Lines; Arthur G. R. MacCullen; Rev. William H. McWhinnie; Colin M. T. Morgan, B.A.; Ian Stuart Parkin, B.A.; Michael B. Rich; Edward G. Roepke; Kenneth Rowe; Dr. Leland Wang; Frank George M. Wheeler; Datoh Haji Mohammed Eusoff bin Mohammed Yusoff, O.B.E., LL.D.; George Isherwood; Charles Frederick Chapman; John William Winson

Elections to Associate Membership: Miss Phœbe Dodds; Donald Peter French; John Gordon Grant; Brian P. Price; Richard St. J. Milroy Hayes

ANNUAL GENERAL MEETING, 25 June 1951. The PRESIDENT, Sir HARRY LINDSAY, in the Chair

The PRESIDENT: Your Excellencies, Ladies and Gentlemen: I am sure you would wish me to begin the proceedings of this meeting by referring to the loss through death of the Rt. Hon. Sir George Clerk. As you know, last year we lost a very valuable Past-President in Lord Chetwode, and this year we have lost Sir George Clerk, also a Past-President, an able supporter and a good friend. He was President during four extremely difficult war years, 1941–45, and was always ready to give of his great experience as a man of affairs in the interests of the Society. I think it was his great ambition not to allow the activities of the Society to fall off in any way that could be helped. There was one period of a few weeks when this hall had to be closed owing to war damage, but he was able to secure the attendance of many distinguished people to address the Society during the war and he was rarely absent himself from its meetings. He always encouraged geographers to put their best work into the interpretation of the many problems which arose during the war. It was a very signal mark of confidence in him that this Society invited him to continue for a fourth year as its President.

I will now turn to the formal business of the meeting.

The Hon. SECRETARY, Mr. Leonard Brooks, then read the Minutes of the Annual General Meeting held on 19 June 1950, which were confirmed and signed by the President.

The PRESIDENT then summarized his Presidential Address which is printed in full on pages 257–262.

The PRESIDENT: We now proceed to the presentation of the Medals and Awards. With the approval of His Majesty the King the Founder's Medal has been awarded to Dr. V. E. Fuchs, Principal Scientific Officer at the Falkland Islands Dependencies Survey's Scientific Bureau, Colonial Office, for his contributions to Antarctic exploration and research as leader of the Survey from 1948 to 1950.

Dr. V. E. FUCHS: In thanking you for this very great honour I should like to say one or two things which I feel sure must have been said a number of times by the people who have received this Award, yet they are very true in this case also. In honouring me you are honouring all those who served with me in the Falkland Islands Dependencies Survey in the Antarctic during the last seven years. I should like in particular to mention those who were with me personally. I have been frequently asked which kind of travel I prefer, the hot or the cold, and it is most difficult to answer. Either makes extreme demands and travel under such conditions means much more than merely getting from one place to another. Nevertheless desert travel, whether hot or cold, has certain characteristics. There is the inability to live off the land itself, the absence of water, and the need for plans to be modified by improvization.

My own particular companions proved able to adapt themselves quickly to the conditions and we worked together with a wholeheartedness and comradeship which was most encouraging. It was only by their efforts that the work and the travel was accomplished. May I say also that we had no mechanical transport. We were fortunate in having dog teams, five of them, and to those dogs we owe a great debt. They were our great friends, and upon their intelligence and stamina and will to work depended our activity.

I thank you for this great honour which is most gratifying to me, and I hope it will be the means of encouraging further Polar research.

The PRESIDENT: The Patron's Medal has been awarded with the approval of His Majesty the King to Dr. Donald Thomson, Research Fellow, Melbourne

University, for geographical exploration and studies in Arnhem Land. I will ask His Excellency the Acting High Commissioner for Australia, if he will kindly receive the Medal on Dr. Thomson's behalf.

The ACTING HIGH COMMISSIONER for AUSTRALIA: I am sorry that Dr. Thomson is not himself present to receive his Medal from the Society. It was impracticable for him to come and in his absence it is an honour for me, as the temporary representative of Australia in this country, to accept this Medal on his behalf. Perhaps I should say that we Australians do ourselves honour Dr. Thomson and recognize how valuable this work has been. In the northern parts of Australia there are still large unexplored areas which no white man has yet seen. It will be a real pleasure for me to pass this award to Dr. Thomson. If he were here he would wish me to say how proud he is to receive it, and I should like to add that it will be an encouragement to him, for he is still a young man, to go farther into the unexplored parts of Australia and to deliver yet more important and interesting addresses to this Society.

The PRESIDENT: The Council have awarded the Victoria Medal to Dr. C. A. Cotton, Professor of Geology, Victoria University College, New Zealand, for his contributions to the geomorphology of New Zealand. In the absence of Dr. Cotton I will ask the High Commissioner for New Zealand to accept the Medal on his behalf.

The HIGH COMMISSIONER for NEW ZEALAND: I have great pleasure in accepting this Medal on behalf of Dr. Cotton and saying "Thank you." It is not only on his behalf but on behalf of New Zealand that I thank you, because the award of this Medal will be a source of pride to my country. New Zealand is only a little more than a hundred years old and it is proud to have produced one who is considered worthy of this Victoria Medal. It is awarded to Dr. Cotton for his contributions to the geomorphology of our country. I found that word difficult to pronounce, and until I searched in a dictionary and tried to work out the meaning from its constituents, I had very vague ideas as to what it meant. We are very proud of what Dr. Cotton has done and on his behalf and on behalf of my Government and people I thank you and the Royal Geographical Society.

The PRESIDENT: The Murchison Grant has been awarded by the Council to Dr. George Salt, Fellow of King's College, Cambridge, for geographical studies of the Shira plateau of Kilimanjaro.

Dr. GEORGE SALT: It is always very pleasing when one's work is recognized in any way and I find special pleasure in this instance because my work on the Shira plateau was really biological, and it was the last thing I should have expected to have been recognized by the Royal Geographical Society. I am very grateful to the Society for awarding me this Grant, and I should like to add that this Award will encourage me to be a better geographer in the future.

The PRESIDENT: The Council has awarded the Back Grant to Mr. J. N. Jennings, Lecturer in Geography, University College, Leicester, for his work on the origin of the Broads.

Mr. J. N. JENNINGS: I should like to say, Sir, that in the year 1941 I was a gunner in the Royal Artillery and finding it impossible to maintain my Fellowship of the Society I wrote to the then Secretary, Mr. Hinks, resigning my Fellowship; but I was informed by him that an American Fellow had that year sent a double subscription with a request that the additional sum be used to pay the dues of a British Fellow, and the Council had decided that the benefit of this American generosity should come to me. I should like to add that the following year, having jumped from the position of gunner to subaltern, I was able to continue my subscription again. I mention this because I find a certain

parallel between it and the Council's action on this occasion. I am grateful for this recognition of the modest contributions I have made to the origins of the Broads and I look upon it as an encouragement to make yet further contributions.

The PRESIDENT: The Council has awarded the Cuthbert Peek Grant to Mr. W. B. Harland, Lecturer in Geology, University of Cambridge, for surveys and mapping in central West Spitsbergen. Mr. Harland has left only today to continue his work in that area and I will ask Mr. Forbes to receive the Grant on his behalf.

Mr. FORBES: It is a great pleasure to me to say "Thank you" on behalf of my friend Mr. Harland for this Award. He asked me to come here and say that the Award was earned not by himself alone but by all the thirteen members of that expedition.

The PRESIDENT: The final Award which the Council have made is the Gill Memorial to Dr. W. R. Mead, Lecturer in Geography, University College, London, for geographical research in Finland.

Dr. W. R. MEAD: Finland is a remote country in Europe; it is now fifteen years since I first went there and, on many occasions before and since the war, I have received the most encouraging and kindly welcome. In thanking you for this honour which the Council have bestowed upon me I feel I must also say, "Thank you" for the warm cooperation of the Finnish people and also for the continuing assistance of the Finnish Geographical Society. I think of many Finnish geographers and many officials in the University libraries and State archives who have made the way easy for me in my research in that country. To-morrow I go back to Finland once more and I shall always recall the encouragement which the Royal Geographical Society has given to my work.

The PRESIDENT then appointed Mr. Duncan Carse and Mrs. Faircloth to act as scrutineers of the ballot for the Council and Officers for the ensuing year. While the ballot was in progress the President, and the Honorary Secretary (Mr. Brooks), drew attention to the main items of the Annual Report which had been circulated to Fellows, and inquired whether there were any questions or comments that Fellows wished to raise.

The Annual Report and balance sheet was unanimously adopted.

Mr. W. CARTER: Last year a talk was given in this hall on the subject of Tristan da Cunha which was not published in the *Journal*. I came here and hoped that I might see a copy of the talk, but was told that it was given at a film meeting and that at such meetings no record of the addresses is taken. A great deal of information is given at these meetings and it occurs to me that if the scripts could be placed on record in the Library for the benefit of Fellows who want to look them up it would be a great advantage.

The PRESIDENT: I do not think I can say more at the moment than that the matter will be looked into. Whether there are questions of expense involved in keeping the records of such meetings I am not sure.

The scrutineers informed the President that the candidates proposed for Council and Officers for the ensuing year had been elected.

Mr. LEONARD BROOKS: Our late President, Lord Rennell, was to have proposed the vote of thanks to the retiring Officers and to those changing office. In his absence I should like to take this duty upon myself. There is one outstanding name that we should mention, that of Colonel Sir Charles Arden-Close who has for forty-seven years given unbroken service as an Officer of this Society. He became a member of Council in 1904 and he has never been off the Council since. He has been a member of Council, Honorary Secretary,

Vice-President, President, and Trustee; he has filled every office in the Society except those of Foreign Secretary and Treasurer. It is with great regret that he has sent in his resignation, but we cannot let him go without sending from this meeting a message thanking him for his great service. His advice on map projections and other matters has been of great value and in spite of his inability to come to the House, he has never failed to fulfil his duties in the Society.

I wish Lord Rennell had been here to express our thanks to our retiring President, Sir Harry Lindsay. During the war we had as Presidents Lord Chetwode and Sir George Clerk, who kept things going. Then in 1945 we had Lord Rennell, who very largely reorganized the committee work of the Society and brought the Society into close touch with outside organizations and government departments. Since then we have had Sir Harry Lindsay who has consolidated the changes introduced by Lord Rennell. Not merely has he consolidated them but he has modified them and added to them in several important respects and he has carried every department of the Society further than it was three years ago.

There is no one who has had better opportunity of seeing changes like that than your Honorary Secretary, and we do thank Sir Harry for his conduct of our meetings and of the Society's affairs. Some of us have sat with him in Council and Committee meetings and whether in those meetings or in the General meetings of the Society he has set a very high standard. He has proved himself a charming personality and a great friend. We thank him very much for all that he has accomplished and we hope that as ex-President he will continue in the work of the Society. I had hoped that Lady Lindsay would be here this afternoon in order that we might thank her for letting us have so much of Sir Harry, particularly in the last year. She has not been very well, and we should like Sir Harry to convey to Lady Lindsay the thanks of the Royal Geographical Society for having enabled him to give so much service especially in these recent difficult times.

The PRESIDENT: It is really most moving to reply to a vote of thanks of this order. I think that only Mr. Brooks could have thought out all those very nice things to say. I feel that many of them are not deserved so far as I am concerned, and yet I must say I have been warmed by what has been said. There is one thing more which I should like to say before I retire, namely to acknowledge the tremendous help the Staff of the Society has been to me, as I am sure it has been to previous Presidents. Speaking from my own experience I have had the most devoted and helpful Staff; they never thought of themselves but always considered the interests of the Society. I thank in particular the Director and Secretary; he has been indispensable and I do not know what I could have done without him.

The PRESIDENT then thanked Fellows and their guests for their attendance and the proceedings terminated.

THE ROYAL GEOGRAPHICAL SOCIETY

KENSINGTON GORE, LONDON, S.W.7

FELLOWSHIP AND ASSOCIATE MEMBERSHIP

The object of the Society being the Promotion and Diffusion of Geographical Knowledge, it has always welcomed to its Fellowship those anxious to further this object by their interest and support, as well as those able to take a more active part in the work of discovery and exploration.

It is provided by Chapter III, § 1, of the Bye-Laws that a candidate for admission to the Fellowship of the Society must be proposed and seconded by Fellows. Further, that a candidate is not to be considered eligible until he has attained the age of twenty-one years, unless he holds a Commission in His Majesty's Forces or is a matriculated student of a University of the United Kingdom or the Self-Governing British Dominions. Proposal forms can be obtained on application to the Director and Secretary, who will also lend if necessary a List of Fellows.

Chapter V, § 1, of the Bye-Laws provides that—

(a) Every Fellow (other than those elected under Chapter III, § 6) shall, except as provided below, be required to pay either on Election Five pounds as Entrance Fee and Three pounds as Annual Subscription for the current year and thereafter an Annual Subscription of Three pounds due on January 1 in each year; or instead of an Entrance Fee on election an enhanced Annual Subscription of Four pounds for the current and five following years, and thereafter Three pounds; or a single Compounding Fee of Sixty pounds.

For Fellows who are under the age of 25 years on election the Entrance Fee shall be reduced from Five pounds to Two pounds; or alternatively the enhanced Annual Subscription of Four pounds shall be payable for the current year and for two following years instead of for five.

Fellows who are on election the wives or husbands of Fellows shall pay no Entrance Fee.

Fellows who are on election the widows or widowers of Fellows shall pay no Entrance Fee if elected within one year of the decease of husband or wife.

(b) Fellows may compound for their Annual Subscriptions at any subsequent time by a payment of £60 (sixty pounds) less £2 (two pounds) for each Annual Subscription paid in excess of five with a minimum of £20 (twenty pounds) after 25 payments.

(c) No Fellow shall be entitled to vote or to enjoy any privilege of the Society while in arrear.

Chapter IIIa of the Bye-Laws, covering the terms of Associate Membership, provides that—

1. Candidates must be not less than 17 and not more than 20 years of age. They must be recommended by a Fellow, University or School authority.

2. Subscription shall be £2 per annum without Entrance Fee.

3. On attaining the age of 21 Associate Members become eligible for Fellowship. The Entrance Fee of £5 shall be waived provided they have been Associate Members for 3 years. Otherwise Associate Membership shall cease at the age of 21.

All subscriptions are payable in advance, on the 1st of January in each year.

The privileges of a Fellow or Associate Member include admission (with one Friend) to all ordinary Meetings of the Society, and the use of the Society's House, Library, and Map-room. Each Fellow is also entitled to receive a copy of all the Society's Periodical Publications. Associate Members have the choice of receiving either *The Geographical Journal* or *The Geographical Magazine*. Associate Members may not describe themselves as F.R.G.S. and have no vote at Annual or Special General Meetings.

A pamphlet giving a brief History of the Society, with a description of its Work and Publications, its Charter and Bye-Laws, and an illustrated account of its House in Kensington Gore, can be sent to anyone interested on application to the Director and Secretary.

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